PETROLEUM REFINER

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WARREN'S MARKETING RECORD
1948
1922
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BIG *Performance*

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Yarways are well suited for refinery work. The small size itself is an important feature. They are easy to install, fit in anywhere, require no special supports.

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Yarways are suitable for all pressures without change of valve or seat. Simplicity of construction (only one moving part) minimizes maintenance. Also, initial cost is low.

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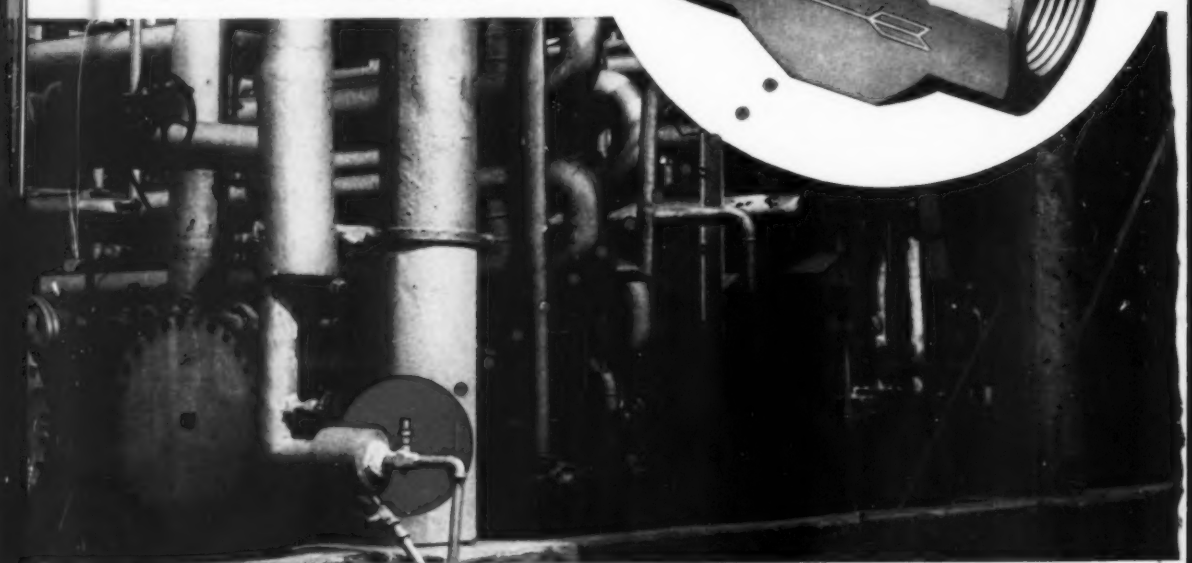

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for the refining-natural gasoline industry

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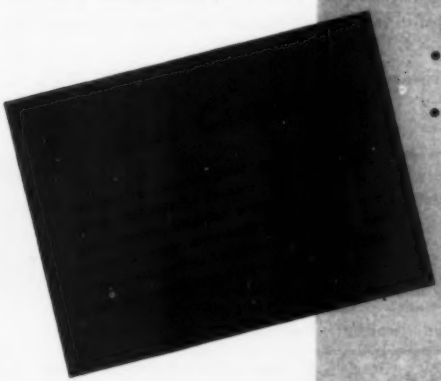

PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President, Publisher A. L. BURNS, General Manager

VOLUME 28, NO. 8 August, 1949

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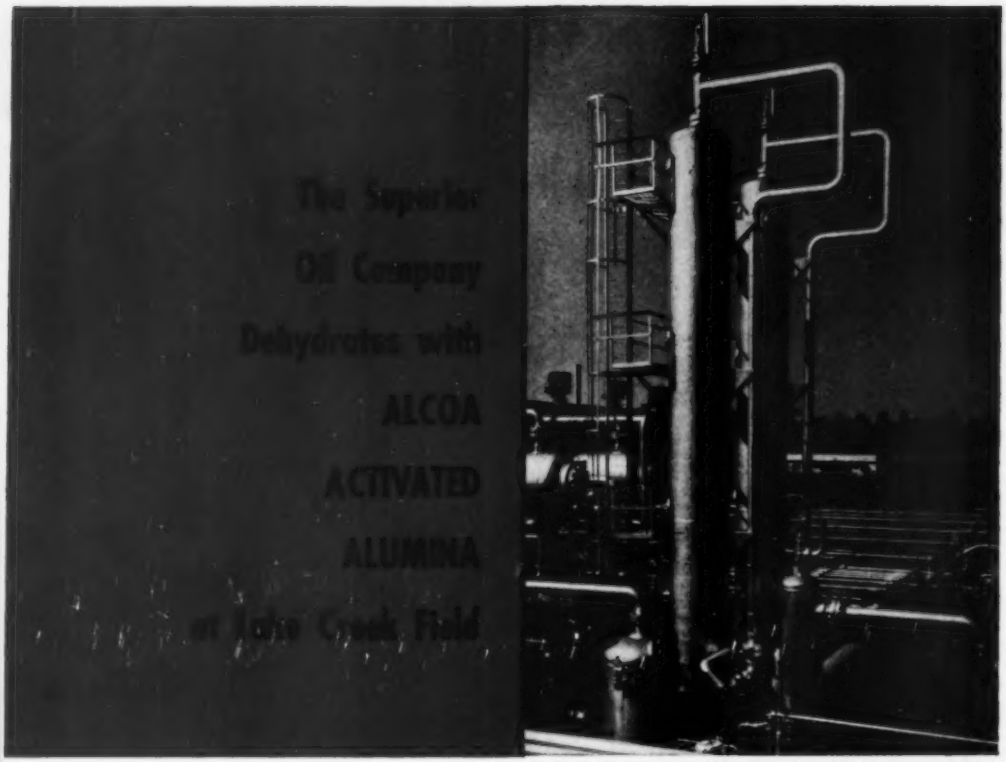

Dehydrating unit at The Superior Oil Company's Lake Creek Field plant. Each tower is charged with approximately 13,000 lbs. of ALCOA Activated Alumina.

The two 35-foot towers shown in the photograph dehydrate approximately 40 million standard cubic feet of wet gas per day. Each tower is charged with 13,000 lbs. of ALCOA Activated* Alumina. The gas is dried, on 8-hour cycles, to a dew point of *minus* 30° F. The operating pressure is 1550 psig.

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Here's a ready cure for maintenance headaches due to stud failures in vital refining equipment . . . and it takes effect the moment you install Republic Upson Alloy Studs wherever severe service conditions are encountered. Providing stubborn resistance to corrosion, high temperatures and heavy pressures, these tough, heavy-duty studs deliver dependable, trouble-free performance under all operating conditions.

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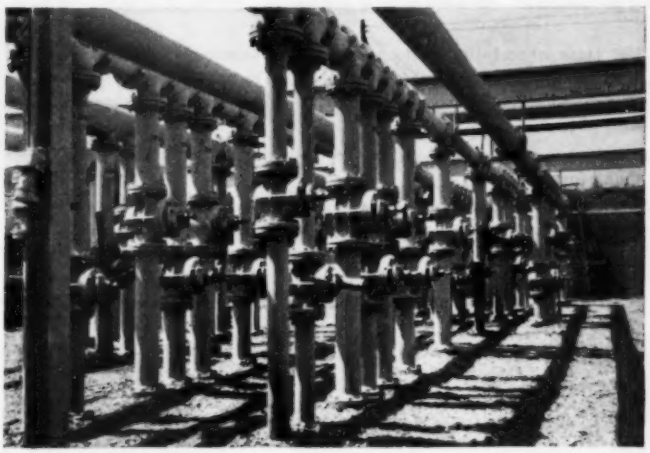

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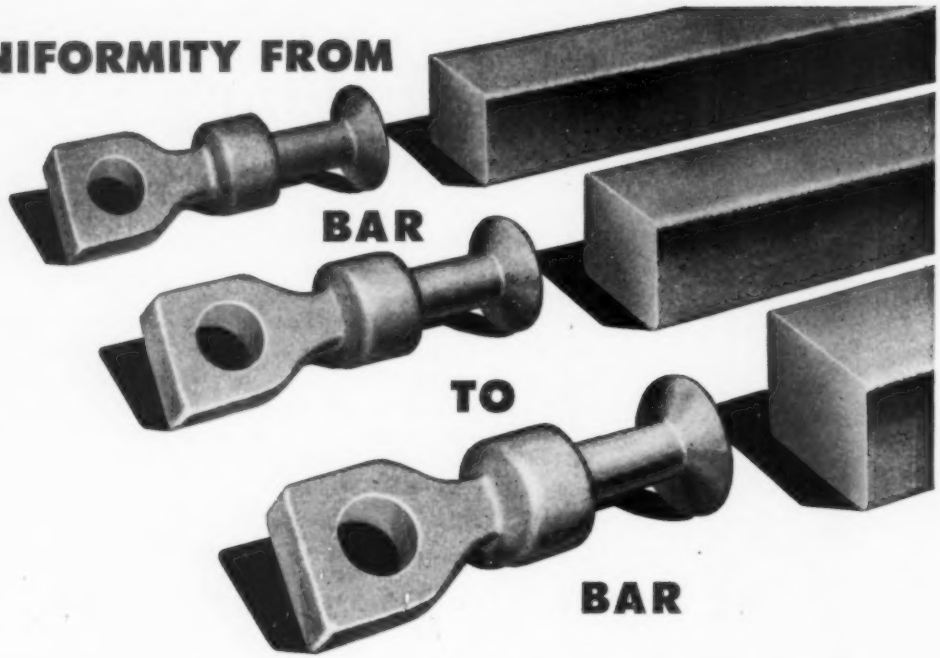

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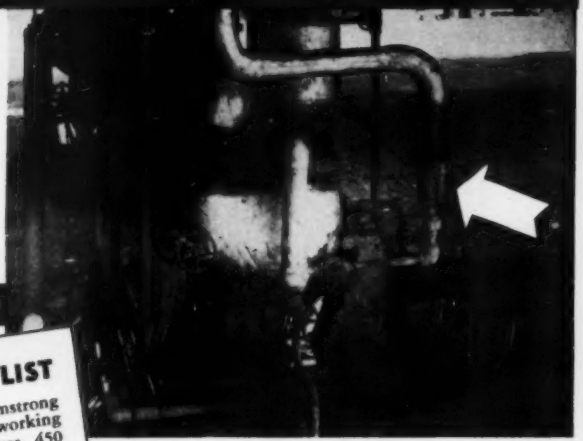
1. **High Shock Resistance.**
2. **Bodies Will Withstand Fire.**
3. **The Cost Is Low.**



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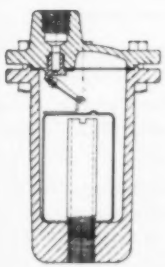
Right—Here's the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi—design pressures, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. Diameter 4¼", height 7", weight 8 lbs. Available with ½" or ¾" connections. Standard Armstrong interior mechanism. Here's forged steel safety for only a few dollars more than a cast iron trap! Available for shipment from stock. Write today.



Cross-section of an Armstrong No. 3211 forged steel trap. Forged cap and body. Compressed graphited asbestos gasket. All stainless mechanism. This trap will take high temperatures and abuse without danger of fracture.

MORE and more refineries and natural Gasoline plants are using ARMSTRONG FORGED STEEL TRAPS, even at pressures as low as a few pounds. The extra safety in case of fire or an explosion more than justifies the moderate additional cost.

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A "standard" in high pressure power plants throughout the world, Armstrong forged steel traps are the perfect answer for extra safety and dependability in the petroleum industry. Prices are modest. For complete data, send for your copy of the ARMSTRONG STEAM TRAP BOOK.

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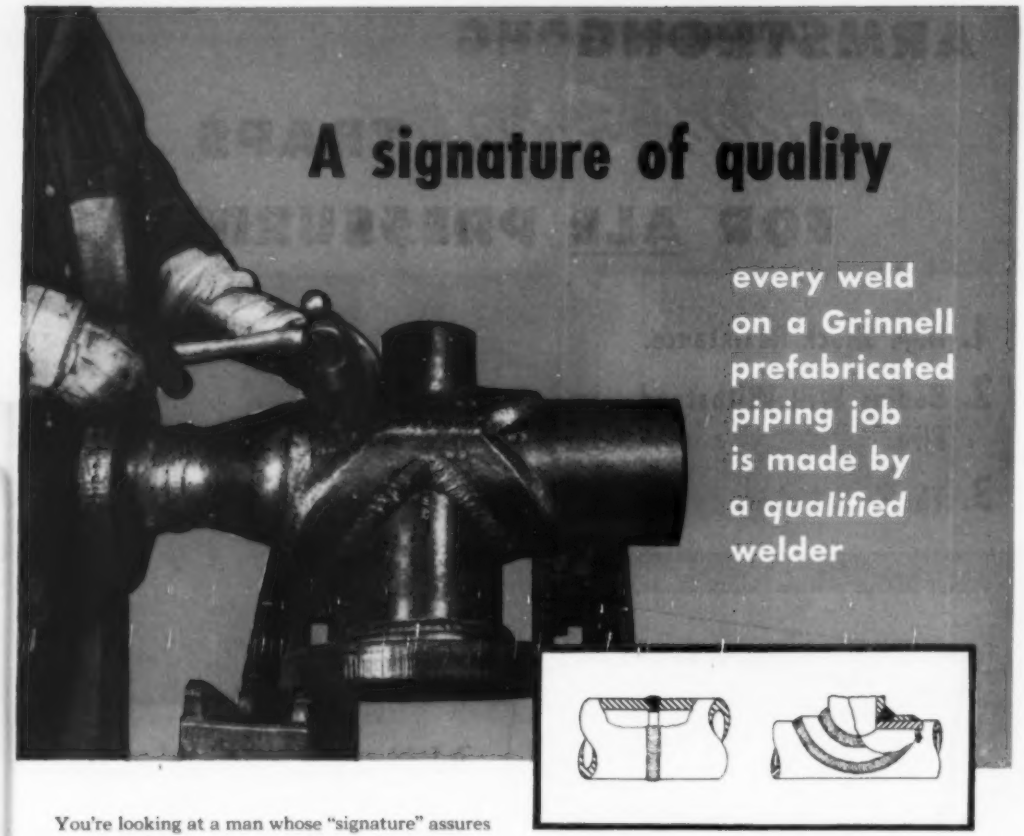

You're looking at a man whose "signature" assures quality welding of piping. He's a Grinnell welder and, as every Grinnell welder, he is qualified by Grinnell according to a procedure which conforms to A.S.M.E. Boiler Construction Code, Section 9. After qualifying, he is given a number which he "signs" adjacent to each weld he makes.

Quality welding is only one of a long chain of responsibilities assumed by Grinnell on every prefabricated piping job . . . from the interpretive engineering to the on-time delivery of the fabricated piping. Such responsibility requires facilities for metallurgical research and testing, comprehensive knowledge of state laws and industry codes, and a complete familiarity with insurance company requirements for fabricated piping.

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With Stainless Steel to safeguard your product from contamination—to prevent off-quality runs —to withstand careless handling and severe use—you can be reasonably certain that as far as your equipment is concerned you have little to worry about.

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These superior qualities of Stainless Steel that pay off in bigger production, fewer shut-downs, and in a better, more uniform product also pay *extra* dividends in making vacations a lot more pleasant by quieting that small inner voice that keeps saying, "Wonder how they're getting along without me at the plant?"

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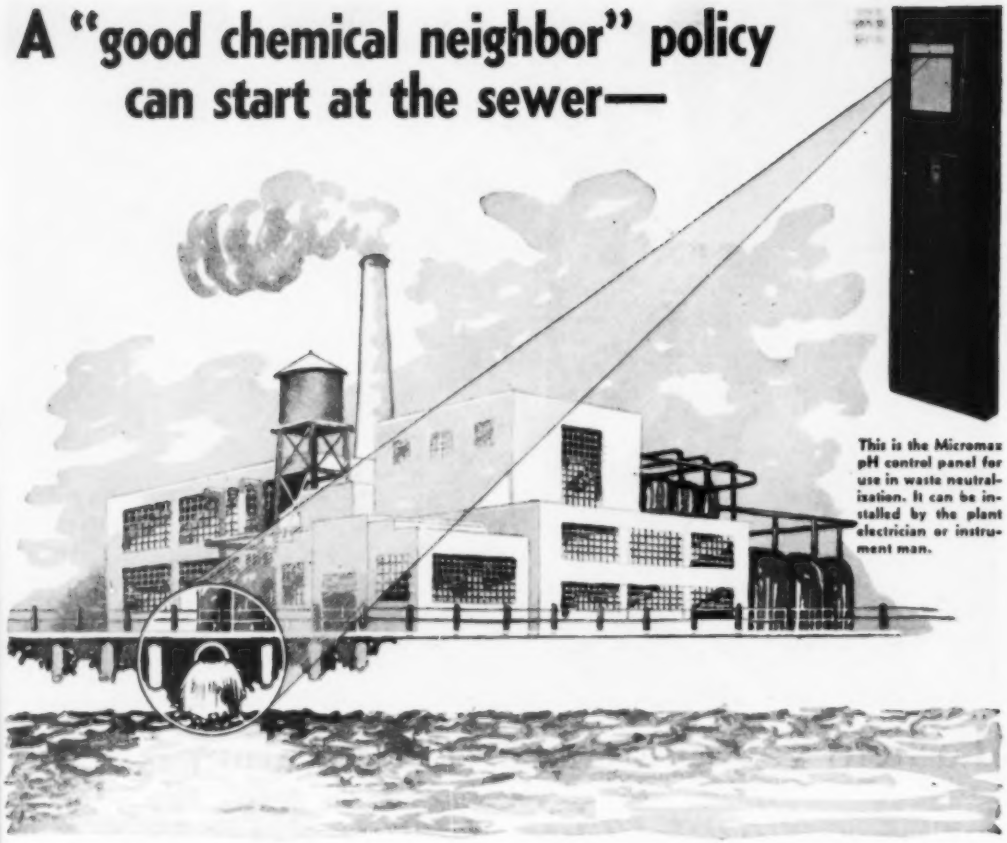
A "good chemical neighbor" policy can start at the sewer—



This is the Micromax pH control panel for use in waste neutralization. It can be installed by the plant electrician or instrument man.

The sewer outfall marks the spot where a plant can prevent stream pollution, by discharging only wastes which have been properly treated. And, when proper treatment is linked to pH control, we can probably help . . . effectively. We can assist engineers to set up good "chemical relations" between a company and the rest of the community . . . make the plant a good chemical neighbor.

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If you're planning pH control, you can't afford to miss this special service. Our catalog "Effective Neutralization of Industrial Wastes" explains controllability analysis in full detail. For your convenience, it also contains a simple questionnaire . . . so we can help you begin solving your plant's pH problems now. You can answer the questions in just a few minutes.

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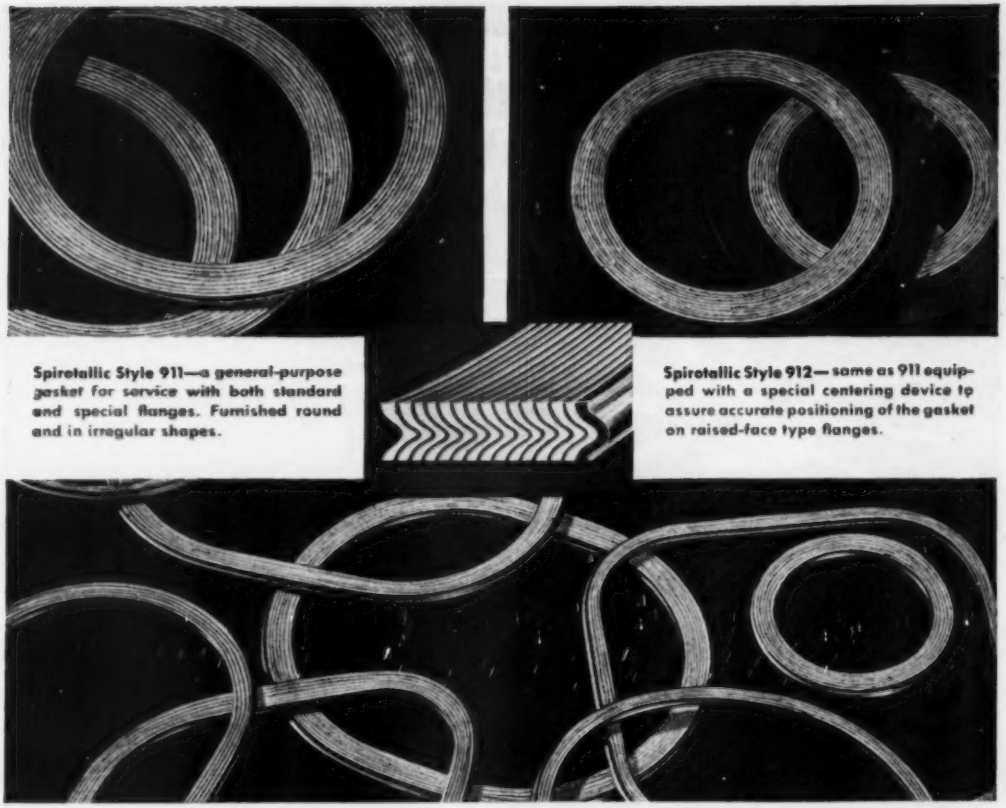

Spirotallic Style 911—a general-purpose gasket for service with both standard and special flanges. Furnished round and in irregular shapes.

Spirotallic Style 912— same as 911 equipped with a special centering device to assure accurate positioning of the gasket on raised-face type flanges.

Spirotallic Boiler Gaskets are furnished for nearly all existent handhole, tube cap and manhole covers for standard makes of boilers, economizers and superheaters.

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If you need a gasket with great mechanical strength *plus* resilience . . . designed to give a perfect seal under practically any service condition . . . Goetze Spirotallics will do the job for you.

Spirotallics owe their unique sealing action to their special construction consisting of a preformed corrugated metal strip cushioned with an asbestos filler *spirally wound*.

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Johns-Manville makes a complete line of industrial gaskets—both metallic and non-metallic types—to meet every service requirement. If you have a special gasket problem write us. Our 75 years of experience is at your disposal to help you solve it.

For complete information write for catalog PK-35A. Johns-Manville, Box 290, New York 16, N. Y.

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NEW Marley FANS
For Cooling Towers and DriCooler*
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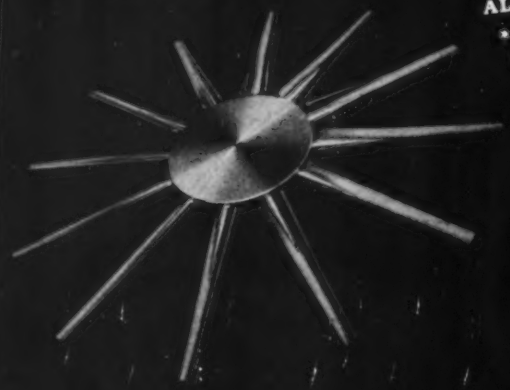

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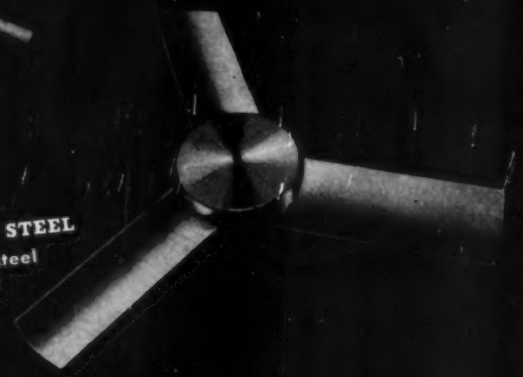
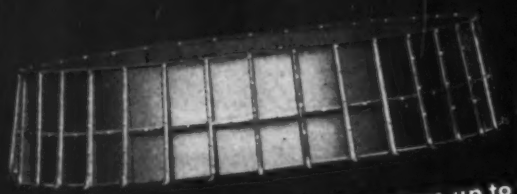
- Unusually quiet and smooth operation
- High tensile cast aluminum alloy
- Adjustable pitch
- Air foil section
- Twisted and tapered blades



STAINLESS STEEL
- All stainless steel
- Adjustable pitch
- Balanced
- Air foil section
- Quiet and smooth operation



FAN CYLINDER
- Unusually rugged
- All bolted
- Flared throat
- Non-corrosive

Marley Fans and Fan Cylinders team up to do the job better . . . longer! These fans are designed and manufactured by The Marley Company especially and exclusively for water cooling applications.

Your new MARLEY Water Cooling Tower or "DriCooler"* will have this equipment, but you can improve your present water cooling tower, right now, regardless of size or make with these new MARLEY FANS.

*DriCooler is the exclusive trade-mark of The Marley Company, Inc., and designates its finned tube dry surface cooling equipment.

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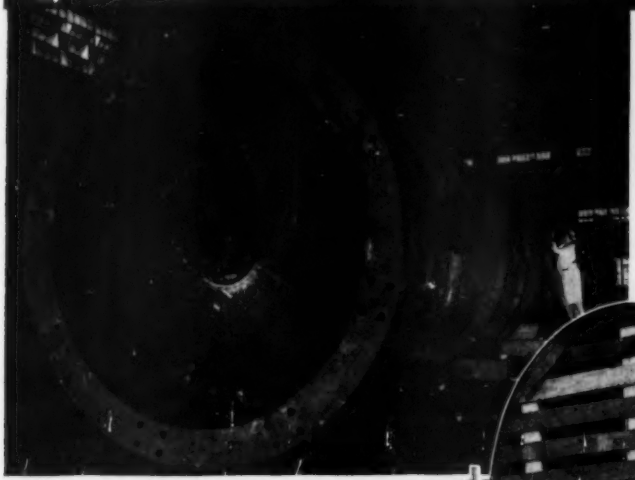
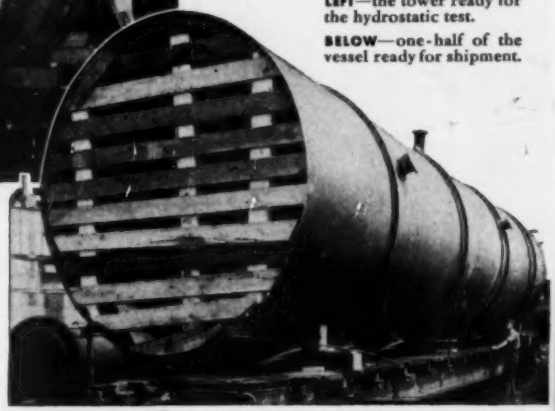


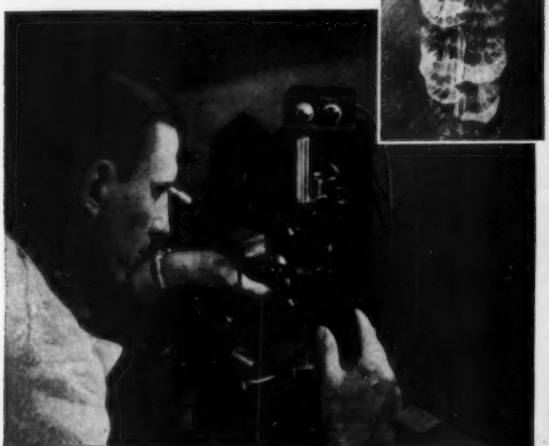
A. O. SMITH TAKES THE GUESS WORK OUT OF FIELD ASSEMBLY. Railroad shipping restrictions made it necessary to field-assemble this 11½ ft. dia. x 116 ft. long SMITHlined Fractionating Tower. To insure ease of assembly in the field, it was first manufactured and completely assembled in the A. O. Smith Milwaukee Plant, then hydrostatically tested, cut in two at the center girth seam, rescarfed for welding in the field, and shipped. Field-assembly costs were cut to a minimum with only one girth seam to be welded.

LEFT—the tower ready for the hydrostatic test.

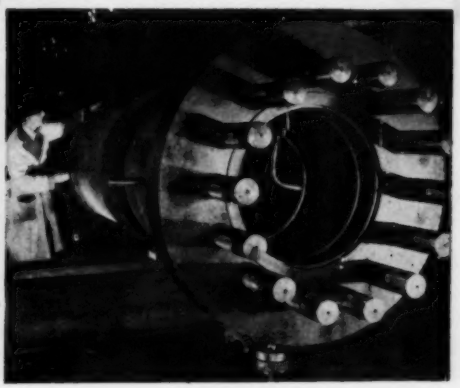
BELOW—one-half of the vessel ready for shipment.



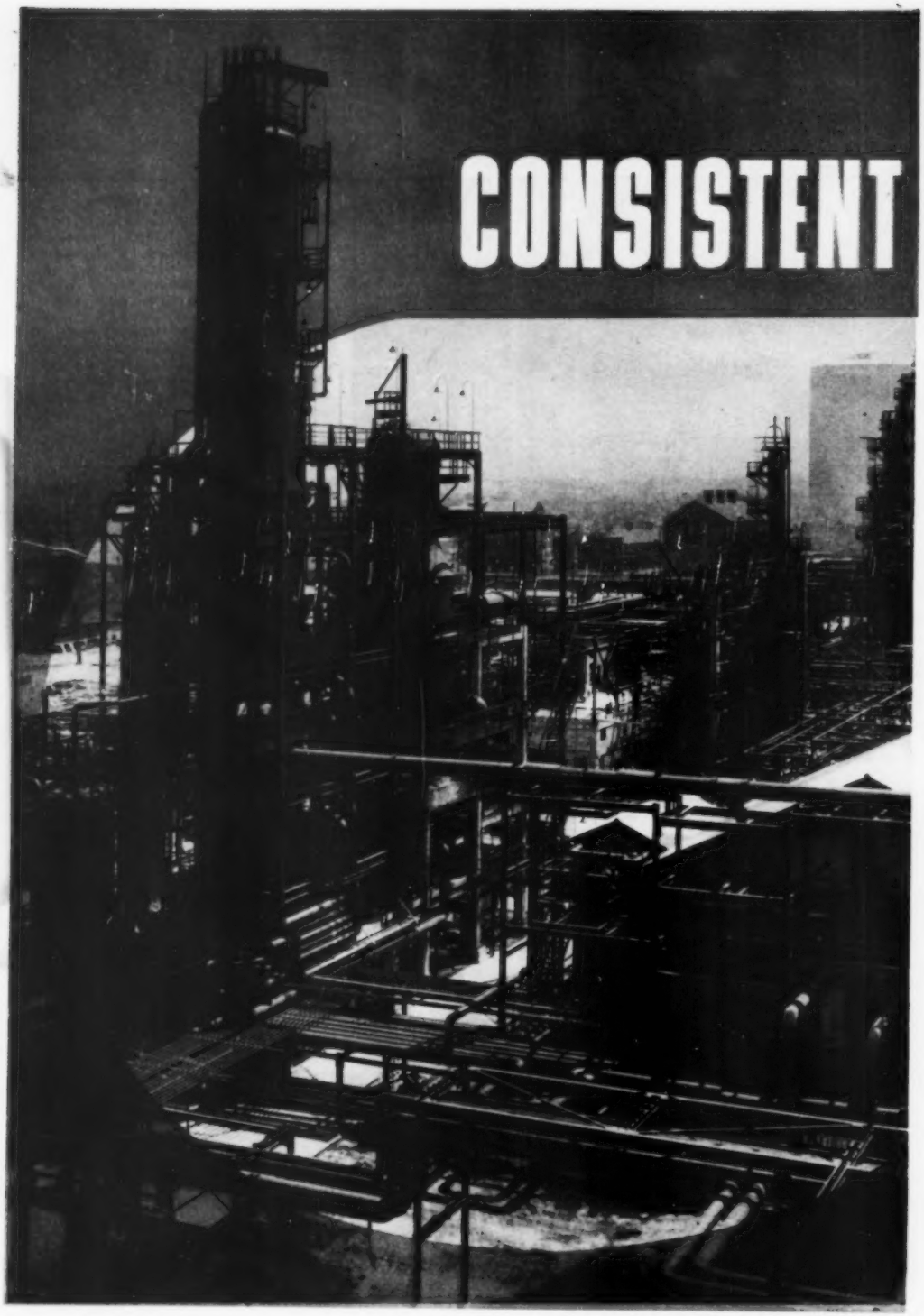
MANY TESTS BEYOND CODE REQUIREMENTS are a regular part of A. O. Smith vessel production control procedures. Here Bill Poehlman, a 20-year veteran, in charge of spectroscopy and X-Ray research, checks the deposited weld metal composition in a vessel test plate, by means of an A. O. Smith-developed microspectrographic technique.

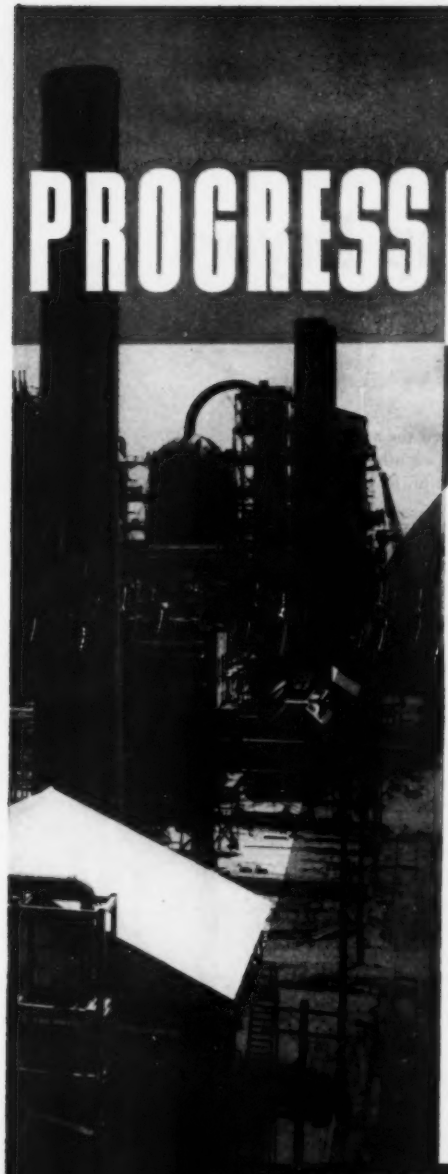


IN STOCKHOLM, SWEDEN, they know about the famous SMITHway welded Multi-Layer vessel construction. Here is one of two SMITHway Inconel-lined Multi-Layer Autoclaves for fatty acid service, with a shell thickness of 5 inches and an operating pressure of over 5,000 psi. This vessel was shipped direct by ocean-going ship from Milwaukee to Stockholm.



NEW BULLETINS: Write the nearest A. O. Smith office listed above for these new Bulletins: V-44—Field Assembly of Pressure Vessels; V-46—SMITHway Vessels, Alloy, Alloy-Lined Clad, and Glass-Lined.


CONSISTENT



PROGRESS

in "The Heart of the Refinery"

This 32,000 barrel combination atmospheric-vacuum topping unit at Gulf Refining Company's Toledo, Ohio, refinery produces light and middle distillates as well as high quality catalytic cracking feed stock from sweet or sour crudes.

Wartime experience demonstrated the necessity for independent primary distillation facilities to maintain refinery balance when processing varying crudes. Hence this is the fourth two-stage unit which Badger has completed for Gulf's post-war program. All were engineered for wide flexibility in operation and with corrosion protection as determined by the economic balance between installation and maintenance costs.

E. B. **BADGER** & SONS CO. · Est. 1841

A SUBSIDIARY OF STONE & WEBSTER, INC.

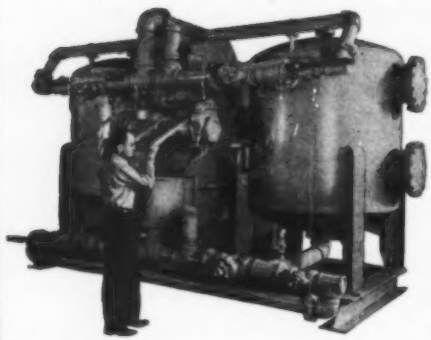
BOSTON 14 · NEW YORK · SAN FRANCISCO · LOS ANGELES · LONDON

Process Engineers and Contractors for the Petroleum, Chemical and Petro-Chemical Industries

2 Years' Savings Paid for this Kemp Dryer

The savings were chemicals previously lost in a single process in this plant!

The Kemp Dryer installation dissipated the vapor-cloud and enabled the operator to see the bottom of a synthetic fibre solution tank, and draw off the full safe amount of the viscous material.



The capacity of this Kemp Dynamic Dryer is 1425 scfm. Air enters at 85° F., saturated, and is continuously dried to a dew-point of 0° F.

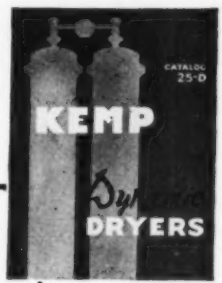
Previously, the tank could be but partly drained, and the remainder then drawn off as waste.

Then too, all air-operated instruments worked better than ever before and there have been reductions in maintenance and labor.

Operation is virtually automatic, requiring brief attention only when the twin towers are alternately reversed from adsorbing to reactivating cycles.

Kemp Dryers are available in a wide variety of sizes and types from portables to giants.

If it must be DRY . . . remember KEMP. But first, perhaps you'd like to talk with a qualified Kemp engineer — there's one not far from you — or see the Kemp Catalog 25-D.



The C. M. KEMP MANUFACTURING CO.
405 East Oliver Street, Baltimore 2, Maryland

☐ Please send me your NEW Catalog D-27 on Kemp Dryers.

☐ Please send a Kemp engineer in to see me.

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APR-8

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KEMP of BALTIMORE

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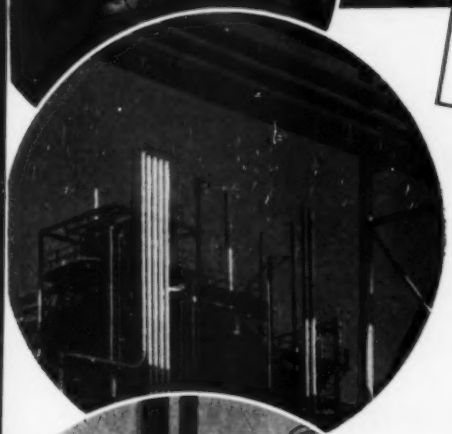
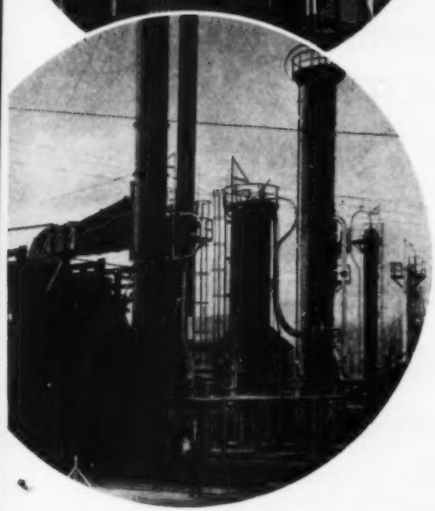
TO SELECT THE PROPER REFINERY TUBING FOR YOUR PLANT





NATIONAL'S *25 different* ANALYSES Cover Practically Every Condition of Temperature, Pressure, Corrosion and Exposure

● When the question of tubing comes up for a new installation or for replacement, don't cross your fingers and "take a shot in the dark," hoping that your choice will be right. Come to Tubing Headquarters. Tell us what conditions are at your plant . . . what you expect of the pipe and tubing you buy. The chances are that we have already helped someone handle a similar situation . . . *and successfully*. In fact our files are filled with case histories, the results of laboratory tests, and actual field observations involving U·S·S NATIONAL Pipe and Tubing under practically every condition of temperature, pressure, corrosion and exposure.

Out of all this research and study have come important developments in tubing steel which enable NATIONAL to now offer you Seamless Steel Tubes, Condenser Tubes, Heat Exchanger Tubes, and Refinery Piping in *25 different analyses*. Each of these 25 different analyses has been performance-proved to meet the specific conditions of corrosion and oxidation for which it is recommended.

FOR STILL TUBES · CONDENSER TUBES HEAT EXCHANGER TUBES · REFINERY PIPING

- Low Carbon
- Low Carbon, ½ Moly.
- Low Carbon, 1 Moly.
- ½ Cr., ½ Moly
- 1¼ Cr., ½ Moly
- 2 Cr., ½ Moly
- 2 Cr., ½ Moly., 1¼ Sil.
- 2¼ Cr., 1 Moly.
- 2½ Cr., ½ Moly., ¾ Sil.
- 3-Cr., ½ Moly., 1¼ Sil.
- 3-Cr., 1 Moly.
- 5 Cr., ½ Moly.
- 5 Cr., ½ Moly., 1½ Sil.
- 5 Cr., ½ Moly., Titanium
- 5 Cr., ½ Moly., Columbium
- 7 Cr., ½ Moly.
- 8 Cr., 1 Moly.
- 9 Cr., 1 Moly.
- 12 Cr., Aluminum
- 17 Cr.
- 18-8
- 18-8 Titanium
- 18-8 Columbium
- 18-8 Molybdenum
- 25-20

We invite you to bring your problems to NATIONAL. Our Tubing Specialists will work closely with your own engineers to see that you get just the right tubes and piping for your particular requirements.

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NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

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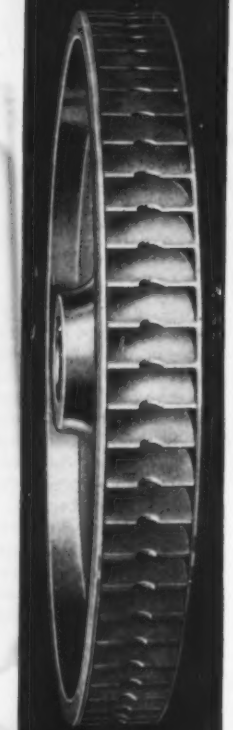
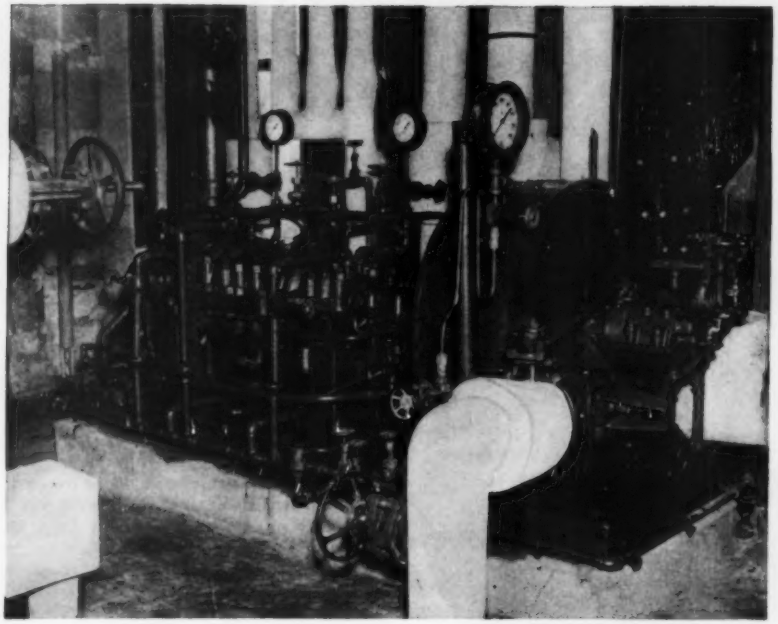




Large Turbine Clearances for DEPENDABILITY *In Desuperheat Control*

In the design of this topping plant emphasis was placed on dependability and continuity of service.

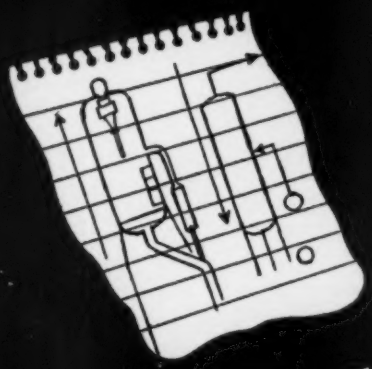
An important feature is pressure reducing and desuperheating 1250 psi, 900 F steam to 400 psi, 600 F, at various rates to meet low-pressure steam and power demands.

For this service the 100 hp Terry Solid-Wheel Turbine, shown above driving a desuperheating water pump, is ideal. It has large radial and axial clearances and protective rims at the sides of the wheel. The blades cannot foul, end play can do no damage.

A descriptive bulletin on this dependable turbine will be sent upon request.

T-1180

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



FULFILLMENT

Fulfillment of contractual guarantees in plant design and construction is to be expected of any well qualified organization. It becomes a basis for preference as engineering commitments are consistently surpassed. Lummus stands ready for evaluation on whatever scale of values means the most to you: output, completion dates, or long initial runs. But the test that Lummus regards as the best evidence of its ability to fulfill your needs is its record of success in bringing *new-process* plants from pilot stage to full-scale operation.

teamwork
economy
perspective
resourcefulness

LUMMUS designs and builds with **FULFILLMENT**

technique

FULFILLMENT (plant capacity)

A catalytic cracking plant, designed for 5400 B/D, was boosted to 6000 B/D on the 85th day of its initial run. Guaranteed percentage yield of high octane gasoline was also exceeded: 3070 B/D of 10-lb. RVP gasoline against a 2040 B/D guarantee.

FULFILLMENT (initial run)

A long initial run accurately forecasts long-term performance almost every time. This 10,000 B/D catalytic cracking plant was first shut down (for inspection) after 240 days on stream. No major maintenance was necessary. Total turnaround time was some 10,000 manhours.

FULFILLMENT (continuous output)

A continuous processing record for this customer—over 1,200,000 barrels of crude—was established by this Lummus high-pressure cracking unit—on the line for 124 days.

FULFILLMENT (completion schedule)

A polyform gas reversion plant, designed to produce 4000 B/D of high octane gasoline, was completed on a tight 10-month schedule. The acceptance test run met all guarantees. The initial run continued 65 days before shutdown for employee-training purposes.

THE LUMMUS COMPANY
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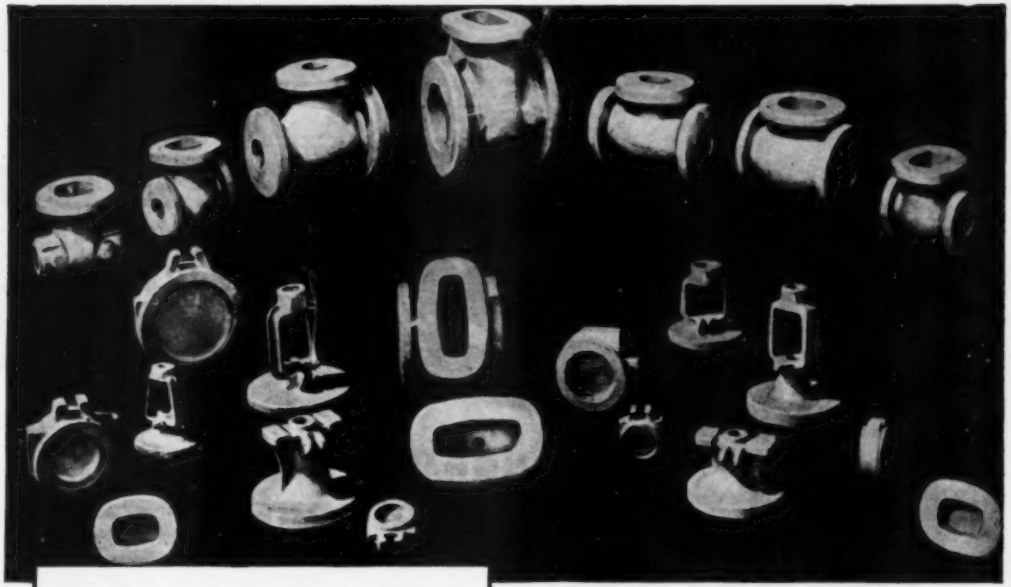
Esquina Las Gradillas, Caracas, Venezuela



INCREASE TOUGHNESS OF CAST PARTS

by using

NICKEL ALLOY STEEL CASTINGS

Advantages

of Alloyed Over Plain Carbon Steel Castings

1. STRONGER...HIGHER YIELD STRENGTH
2. LESS BULK AND DEADWEIGHT
3. BETTER RESPONSE TO HEAT TREATMENT
4. GREATER SHOCK RESISTANCE
5. GREATER FATIGUE STRENGTH
6. LESS EMBRITTLEMENT AT SUB-ZERO TEMPERATURES
7. BETTER STRENGTH AT ELEVATED TEMPERATURES

Cast steels containing 0.15% maximum carbon and 3½% nickel have shown an inherent toughness exceeding 15 foot-pounds Charpy (keyhole notch) impact resistance at temperatures down to minus 150° F. In this class are the valves and fittings, shown above, cast by Fort Pitt Steel Casting Division of Pittsburgh Steel Foundry Corp., McKeesport, Pa.

On the other hand, the WC4 and WC5 Types of nickel alloyed steel castings made to ASTM Specification A217 provide essential high strength properties for service at temperatures up to 1050° F.

Typical applications for nickel alloy steel castings include:

- Vapor channels
- Dewaxing equipment
- Valves and fittings for low temperatures
- Valves and fittings for high temperatures
- Tube supports
- Return bends
- Floating tube heads
- Miscellaneous heat exchange parts
- Pump parts

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Please send me your 32-page booklet entitled "NICKEL ALLOY STEEL CASTINGS IN INDUSTRY."

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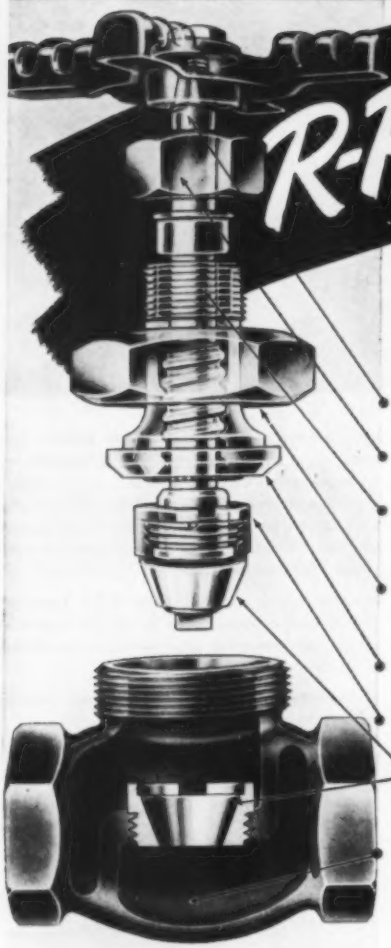
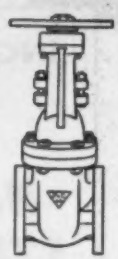
R-P & C HEAVY-DUTY BRONZE GLOBE VALVE



FOR TOUGH THROTTLING CONDITIONS

500 BRINELL DISC AND SEAT

- **STEM** high tensile rolled bronze. Large diameter and long thread contact.
- **PACKING NUT** and gland follower of heavy bronze transmit even pressure onto packing.
- **STUFFING BOX** large and deep. Packed with formed rings of braided asbestos, lubricated and graphited. Can be repacked under pressure.
- **UNION NUT** heavy, rugged. Facilitates removal and replacement without danger of distorting body or threads.
- **BEVELED JOINT** permits tighter union between body and bonnet.
- **DISC LOCK-NUT** holds disc securely to end of stem.
- **FULL-PLUG DISC and SEAT RING** stainless steel of 500 Brinell—near diamond—hardness.
- **BODY** P & C High Test Bronze. Reinforcing ribs give added strength. Heavy end hexes with standard, full length threads.



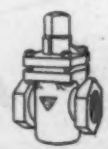


Fig. 531-P

350 lbs. Steam • 1000 lbs. OWG

Send **FOR THIS FOLDER** *which contains a detailed description of this valve. Ask for* **DH-116**

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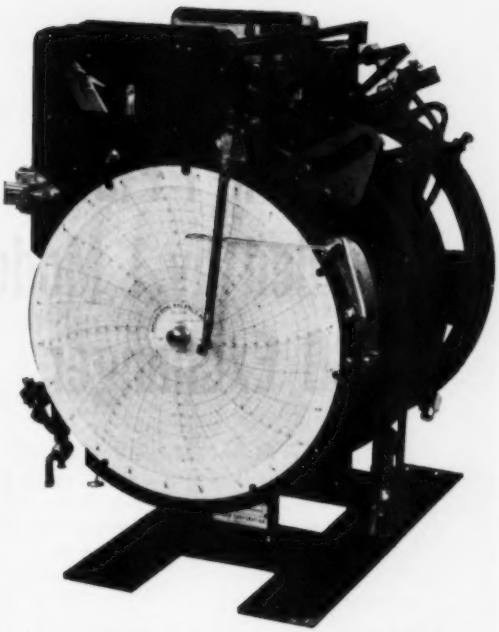
TRADE MARK

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

four typical flow-metering services of Hagan Ring Balance Dual Meters



One common type of Ring Balance Dual Meter is the Hagan Boiler Meter, shown above. Low pressure ring measures air flow, high pressure ring measures steam flow.

The Hagan Ring Balance Dual Meter is, essentially, two meters housed in a single standard-size meter case and recording on a single chart.

Both of the ring assemblies used may be high pressure, or both low pressure, or one may be high and one low. They may operate independently, or they may be linked together so as to produce a compensated record.

These four applications are typical of the flow measurements which are possible with this versatile meter:

1. Measurement of two independent flows, such as air flow and steam flow, or air flow and gas flow, recording both on the same chart and thus providing a direct record of the relation between the two.

2. Independent measurement of two flows, with automatic totalization of these flows, as for example, steam flow from a boiler having two outlets, or to a process having two inlets.

3. Measurement of two flows and of the difference between them. In the case of a split flow this permits measurement of main flow and of one portion, the difference being the other part of the split flow. Any two of these flows may be automatically integrated: all three may be recorded on the chart.

4. Measurement of reverse flows, either with or without automatic integration of the net difference. This application is particularly useful in the case of tie-in lines between boiler houses; where utilities or plants exchange gas; and in similar situations.

The Hagan Ring Balance principle applies also to measurement of the specific gravity of liquids, and density of gases, hence the Dual meter is used to measure flows in which these factors must be taken into account. Measurement can be compensated for temperature or pressure or both.

For more detailed information, fill in the coupon below or write, describing the particular application in which you are interested, to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
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Please send me further information on Hagan Ring Balance Dual Meters.

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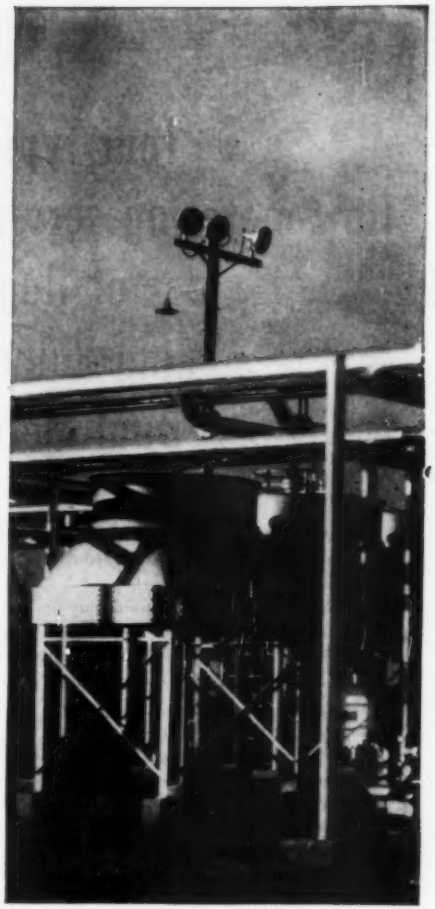
PR-8

6 Tough Cooling Duties in 1 Plant Handled by 1 Model ALCO Exchanger



The Skelly Oil Company gas plant at Velma, Oklahoma, built by the Born Engineering Company of Tulsa, presented a unique problem in certain process cooling requirements. Six different cooling jobs had to be handled in one battery, calling for different heat loads, temperature ranges and operating pressures.

One Alco air-cooled heat exchanger model (the uni-bundle*) was selected to handle all these cooling duties. The customer advises, "Units are operating successfully at over-design capacity." A fine example of how Alco *standardized* air-cooled exchangers can be tailored to suit customer needs—simplifying operation, maintenance, replacement of parts. Alco's *standardized* models bring low cost per year of operation and multiple savings in upkeep costs.

*Trademark patented

ARE YOU FACED WITH ANY OF THESE COOLING PROBLEMS?

- Insufficient water supply
- Scale from bad or brackish water
- Expensive water treatment
- Difficult waste water disposal
- High pumping costs
- High relative humidity
- Excessive space requirements for cooling basins

THEY CAN BE SOLVED INEXPENSIVELY BY ALCO AIR-COOLED EXCHANGERS

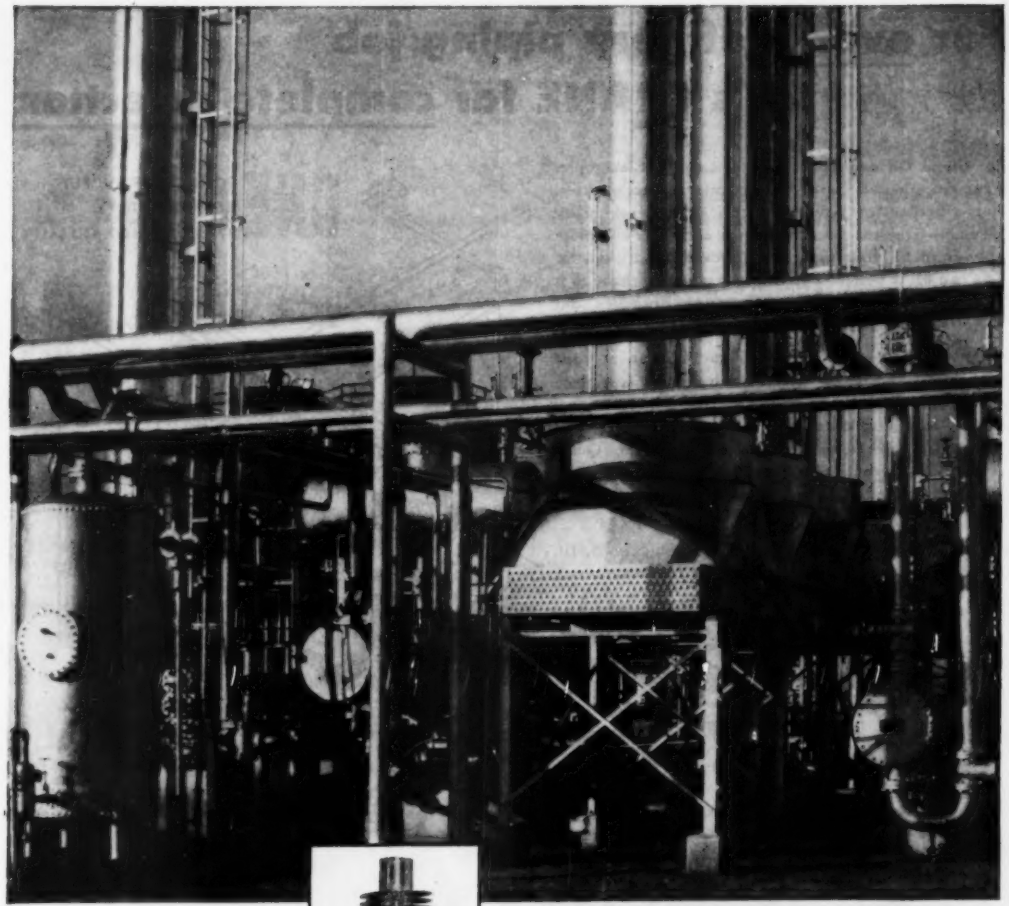
Proved in use in many of the nation's largest gas plants, in pump line stations, in power stations, in diesel locomotives—in many varied applications—Alco exchangers may be the answer to your specific problem.

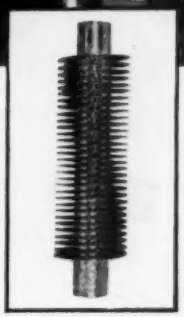
ADVANTAGES OF ALCO DESIGN

1. Volume production means standardized parts, easy maintenance, low cost per year of operation.
2. Simple field installation of standardized components.
3. Fans may be driven by any form of power.
4. Natural draft construction increases efficiency, reduces power requirements. Sometimes this natural draft is sufficient to produce adequate cooling without use of fans.
5. Wind direction and velocity do not affect efficiency.
6. Cooling surfaces positioned to minimize damage from wind-driven sand, rain, hail.
7. Induced draft insures uniform distribution of air across cooling surfaces.

FIN-TUBE MODELS CAN PERFORM MULTIPLE DUTIES

Selection of type of cooling surface to be used should be determined by economics and process requirements. As manufacturers of both radiator core and fin-tube types, and also as one of the world's largest makers of heat exchangers, Alco is in a position to give impartial advice.





Quality controls of Alco fin-tube manufacture assure highest heat dissipation rate. Fins wound on under pressure and permanently bonded on tube by means of solder bath completely covering fin and tube. Easy to handle, easy to clean with compressed air.

ADDITIONAL ADVANTAGES OF FIN-TUBE MODEL

1. Separate surfaces for separate cooling duties can be mounted in the same unit.
2. Header design permits variation of passes to suit process requirements of a given job, thus allowing selection of minimum surface within pressure drop limitation of the process while maintaining maximum velocity required for highest rate of heat transfer.
3. Orifices built into manifold-header design assure uniform distribution to entire cooling surface.
4. Bundle design of Alco fin-tube construction eliminates air leaks.

WRITE FOR FREE BOOKLET, just off the press, containing engineering, design, and selection data on Alco air-cooled heat exchangers. Learn how Alco can help you.

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HEAT EXCHANGER HEADQUARTERS

Dunkirk, N. Y. Beaumont, Texas

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☐ Please send me your Free new booklet on air-cooled heat exchangers.

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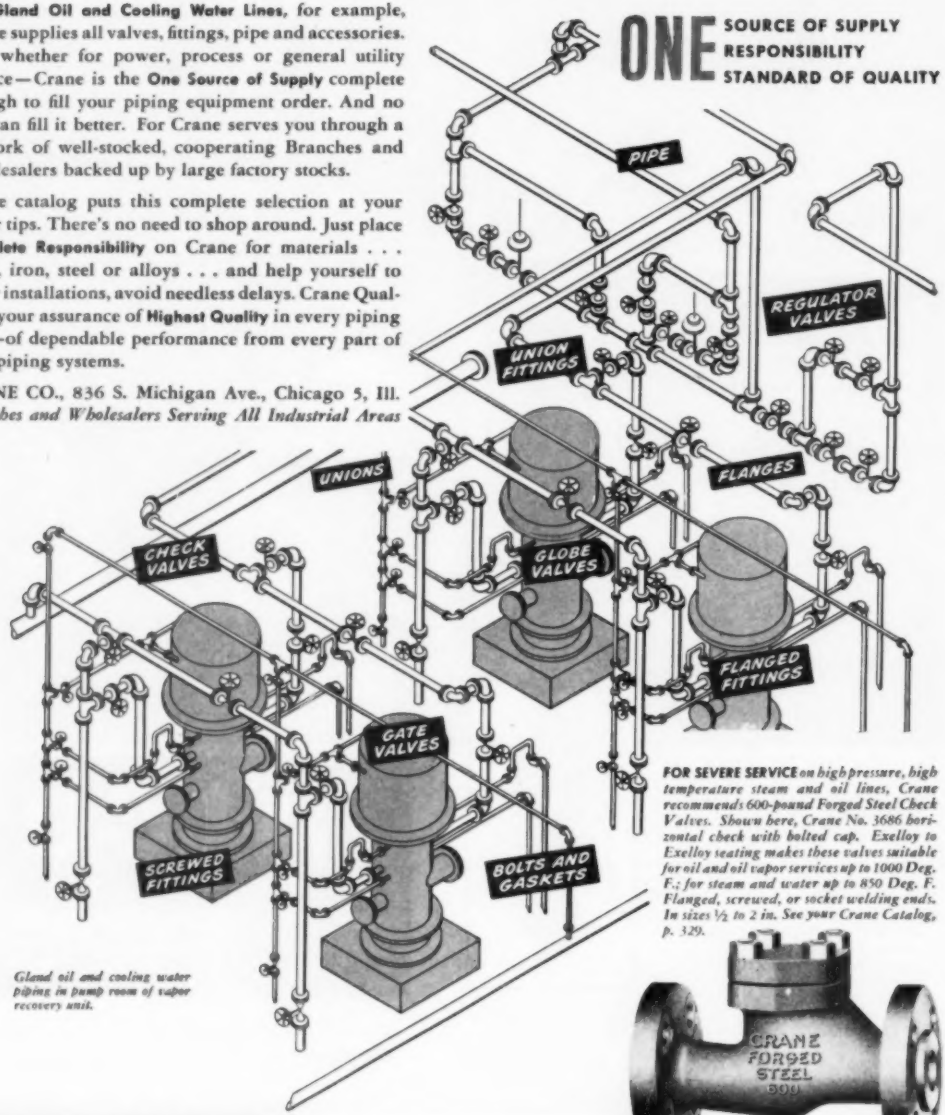
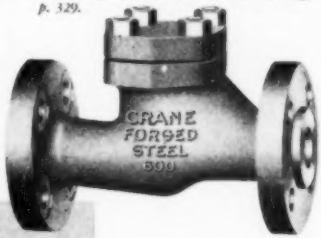


Gland oil and cooling water piping in pump room of vapor recovery unit.

FOR SEVERE SERVICE *on high pressure, high temperature steam and oil lines, Crane recommends 600-pound Forged Steel Check Valves. Shown here, Crane No. 3686 horizontal check with bolted cap. Exelloy to Exelloy seating makes these valves suitable for oil and oil vapor services up to 1000 Deg. F.; for steam and water up to 850 Deg. F. Flanged, screwed, or socket welding ends. In sizes ½ to 2 in. See your Crane Catalog, p. 329.*



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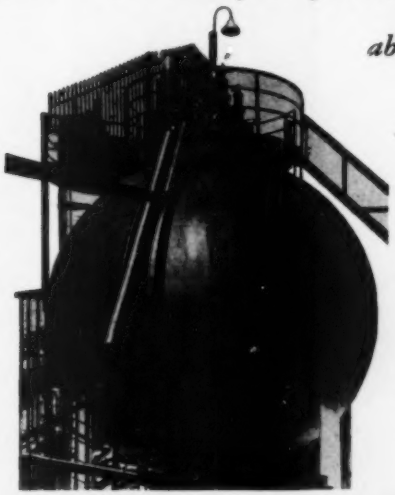
During many years of desalting activity, Petreco has stressed always the importance of fast, effective service. When refiners cite benefits such as more time on stream, lower maintenance costs and increases in refining capacities, we know that such benefits result directly from Petreco's high efficiency salt removal. However, we also believe that the Petreco service organization, whose know-how and experience are unequalled in the industry, is of substantial assistance in providing more profitable refining through more efficient desalting.



FOR THE BEST IN DESALTING
FOR THE BEST IN SERVICE

PETRECO
Electric
DESALTING

PETROLEUM RECTIFYING COMPANY
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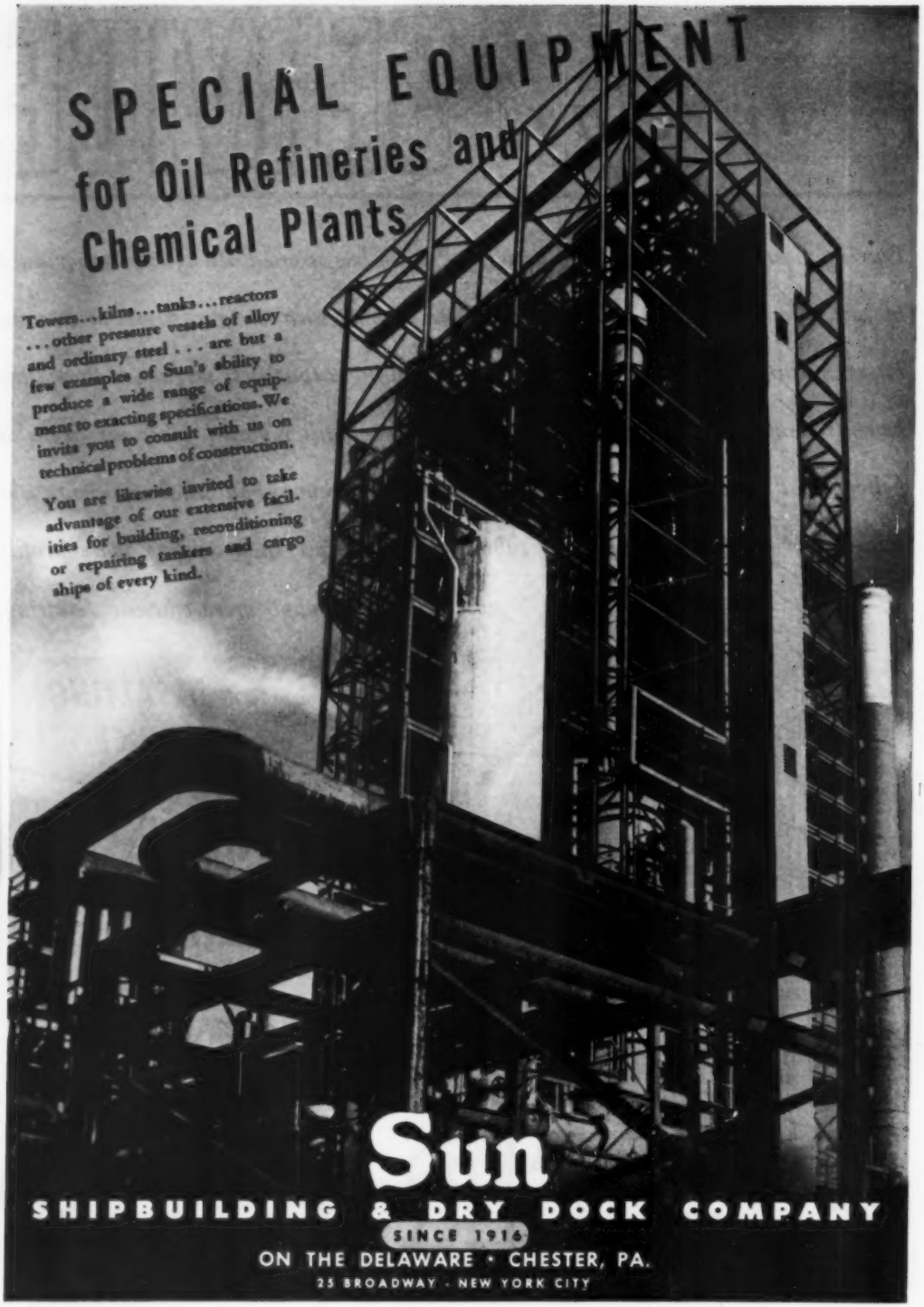
PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { **DESALTING** / **DEHYDRATING**

PR-49-4


SPECIAL EQUIPMENT
for Oil Refineries and
Chemical Plants
Towers...kilns...tanks...reactors ...other pressure vessels of alloy and ordinary steel . . . are but a few examples of Sun's ability to produce a wide range of equipment to exacting specifications. We invite you to consult with us on technical problems of construction.
You are likewise invited to take advantage of our extensive facilities for building, reconditioning or repairing tankers and cargo ships of every kind.
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SHIPBUILDING & DRY DOCK COMPANY
SINCE 1916
ON THE DELAWARE • CHESTER, PA.
25 BROADWAY - NEW YORK CITY

how to GET MORE WELDING from your PIPE WELDERS

The exceptional accuracy and uniformity of Midwest Welding Fittings enable the welder to spend more time in welding and less time in preparation. He does not have to struggle to line up fittings and pipe . . . all pipe can be cut in advance according to drawings . . . he need never compensate for inaccuracies. Time and money savings are substantial.

The dimensional accuracy and uniformity of Midwest Welding Elbows result from a unique method of manufacture. These elbows are first made slightly oversize . . . then reheated to forging temperature and brought to final size in compression dies. This assures true circular cross section, uniform wall thickness and accurate radius, included arc and tangents.

Midwest Welding Fittings save you money . . . there is a distributor near you . . . it will pay you to call him.

3718

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PIPING & SUPPLY COMPANY, Inc

MAIN OFFICES: 1450 SOUTH SECOND ST., ST. LOUIS, MO.
PLANTS: ST. LOUIS, PASSAIC (N.J.) and LOS ANGELES

MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs

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New York (7), 30 Church St. • Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.

When you use WOLVERINE TRUFIN

Wolverine Trufin (the finned tube whose fins are integral with the tube itself) provides the necessary surface area in just a small fraction of the space that plain tube demands to meet the same requirements in heat exchangers. That brings you the advantage of either operating with the same efficiency in much smaller space or gaining increased efficiency from the same sized equipment.

Trufin, remember too, is not affected by vibration or extreme temperature changes, which are added advantages that assure long, dependable performance.

Trufin is available in several alloys, in many fin heights and spacings, and in most popular sizes.

Send for our brochure that gives much helpful information regarding use of finned tube in heat exchangers.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
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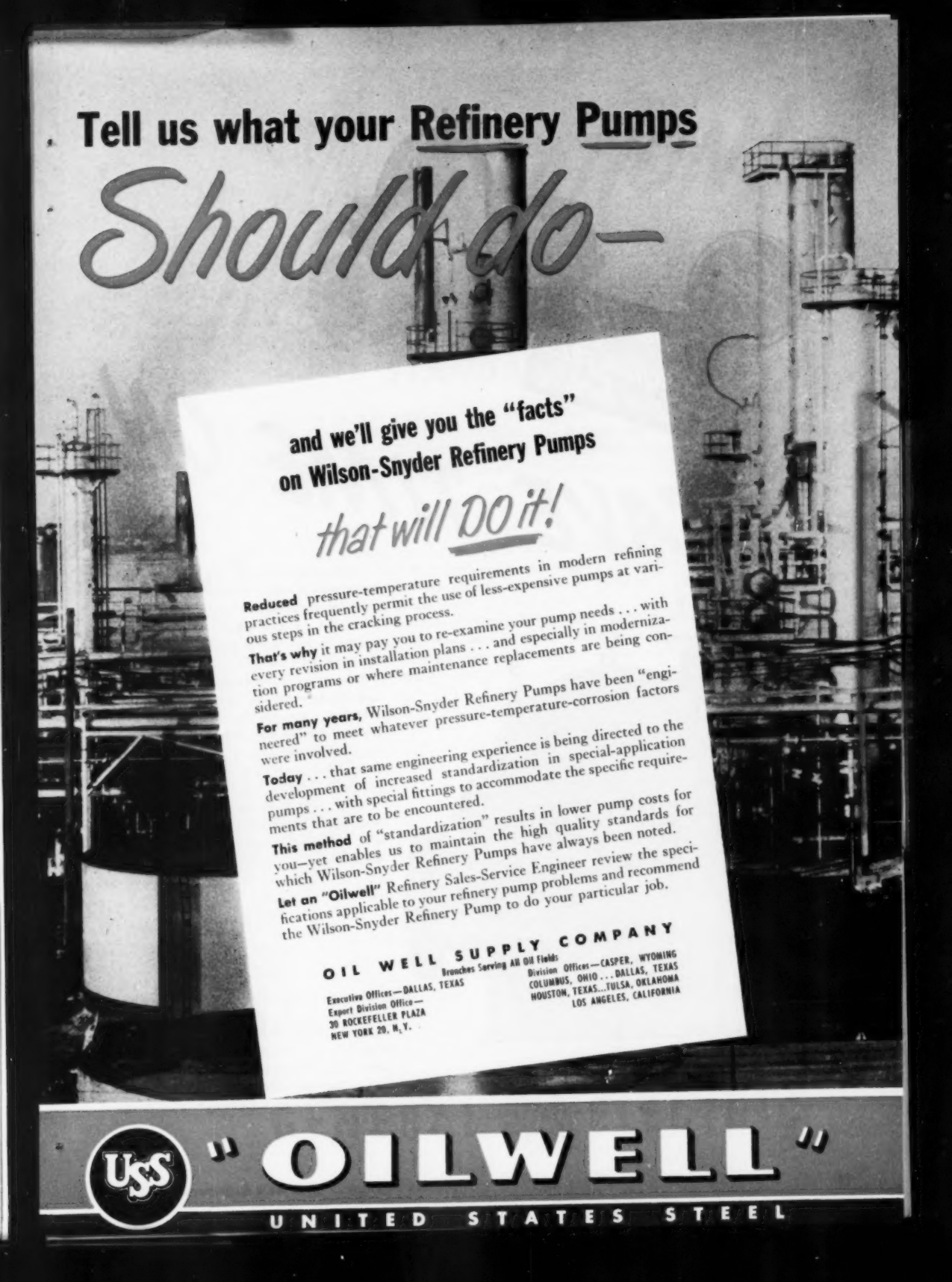
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING

1431 CENTRAL AVENUE • DETROIT 9, MICHIGAN


Tell us what your Refinery Pumps
Should do—
and we'll give you the "facts"
on Wilson-Snyder Refinery Pumps
that will DO it!
Reduced pressure-temperature requirements in modern refining practices frequently permit the use of less-expensive pumps at various steps in the cracking process.
That's why it may pay you to re-examine your pump needs . . . with every revision in installation plans . . . and especially in modernization programs or where maintenance replacements are being considered.
For many years, Wilson-Snyder Refinery Pumps have been "engineered" to meet whatever pressure-temperature-corrosion factors were involved.
Today . . . that same engineering experience is being directed to the development of increased standardization in special-application pumps . . . with special fittings to accommodate the specific requirements that are to be encountered.
This method of "standardization" results in lower pump costs for you—yet enables us to maintain the high quality standards for which Wilson-Snyder Refinery Pumps have always been noted.
Let an "Oilwell" Refinery Sales-Service Engineer review the specifications applicable to your refinery pump problems and recommend the Wilson-Snyder Refinery Pump to do your particular job.
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Executive Offices—DALLAS, TEXAS
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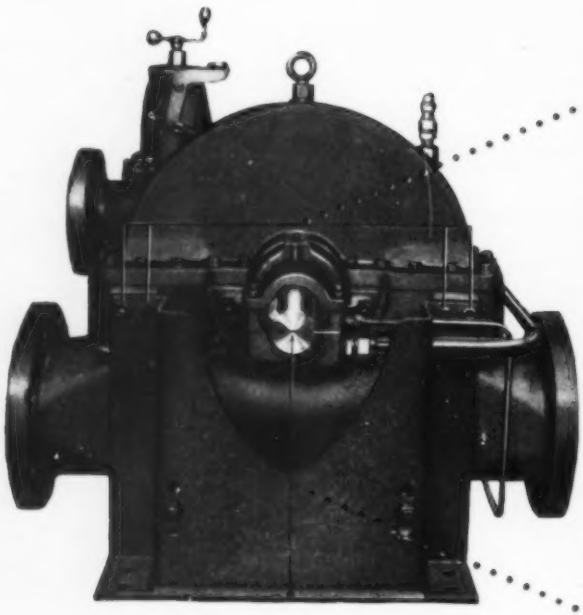
"OILWELL"
UNITED STATES STEEL

Type DP Mechanical-Drive Turbine

SAVE TIME ON



Turbines supported at the centerline save many mis-alignment headaches both during and after installation. In general, this method of support cuts down shaft "lift" from casing heating to less than a quarter of the lift of foot-supported units.

Thus, unless casing temperatures are high, G-E standard turbines can be lined up cold with the assurance that shaft lift will be within allowable limits when the turbines are heated. No calculations or adjustments for setting the shaft low when cold will be required.

With the unit in line hot or cold, shaft whipping, which often causes bearing burn-outs, excessive vibration, and coupling wear, is eliminated.

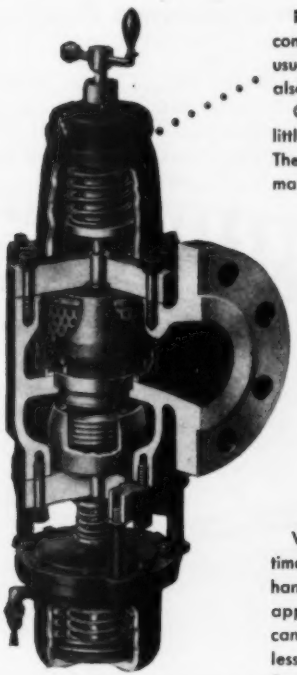
You save time when coupling the turbine to the driven unit, since the shaft height is identical on all G-E standard turbines. Not only that, but shaft diameter, keyway dimensions, etc., are identical on all turbine frame sizes. This standardization saves lost motion when installing or re-locating turbine drives.

INSTALLATION!

WITH GENERAL ELECTRIC STANDARD TURBINES

SAVING time when installing or re-locating turbines is one of the important advantages of using G-E standard turbines. Many other advantages: wider range governing, pressure lubrication, fewer wearing parts, are also standard with the Type DP —at no extra cost.

If you are planning installation of turbines, check with your G-E representative. He'll gladly give you application assistance and complete data. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*



Piping is simplified with G-E standard turbines. The combined trip-throttle valve—an exclusive G-E feature—usually makes a separate shut-off valve unnecessary. This also saves the cost of an extra valve.

Once installed, the combined trip-throttle valve requires little maintenance. There are no soft packings to replace. The steam strainer in the valve assembly is easily removed, made of Monel metal to resist corrosion.

With a new installation there's no need for you to spend time selecting spare parts it may be desirable to have on hand. This standard set of packaged spares contains parts applicable to DP turbines of all ratings. One set of spares can thus service several turbines. The price is very low—less than 25% of the price of a comparable set of spares for previous designs—thanks to standardization.

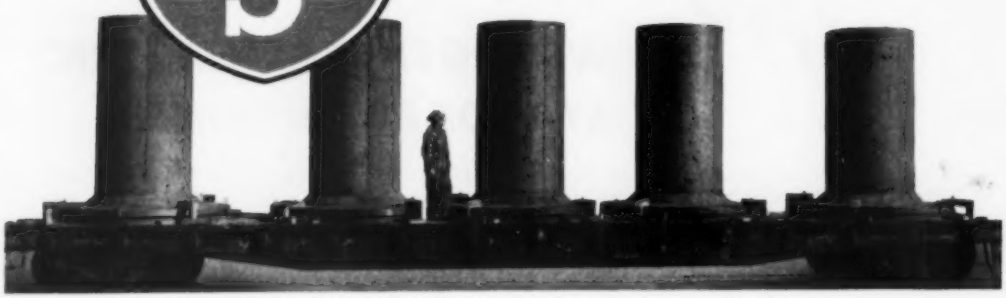
GENERAL ELECTRIC

The PRESSED STEEL CO.

PSC

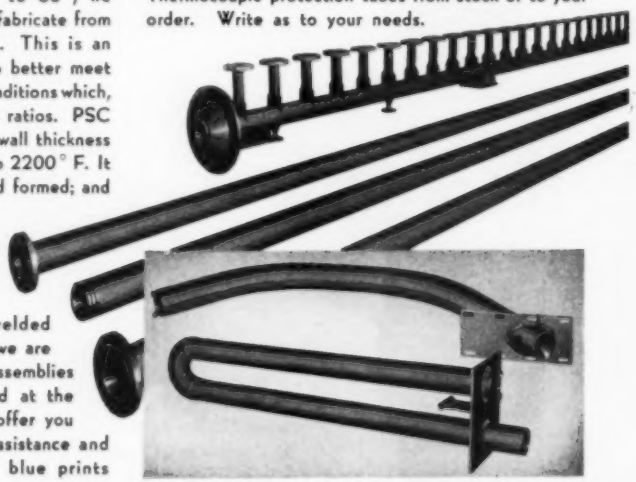
Specialists in

BIG ALLOY TUBING



IN ANY ALLOY *to Meet Your Specific Heat or Corrosion Problem*

As suppliers of welded alloy refining equipment for almost 25 years, Pressed Steel Co. offers you a wealth of experience in fabricating welded alloy tubing. Furnishing any diameter up to 60", we specialize in the larger diameters. We fabricate from the complete list of available alloys. This is an advantage that enables PSC tubing to better meet particular heat, corrosion or oxidation conditions which, in turn, is resulting in better life/cost ratios. PSC welded alloy tubing is furnished in any wall thickness from 1/16" to 3/8"; temperatures up to 2200° F. It can be readily bent, coiled, swaged and formed; and butt-welded to make any required length. Chemical and physical perfection of PSC tubing is assured by hydrostatic, tolerance, surface and straightness tests. Thermocouple protection tubes from stock or to your order. Write as to your needs.



Tube Assemblies Fabricated to Your Blue Prints, in Any Metal

As one of the largest suppliers of welded alloy tubing to the process industries, we are called upon to custom-fabricate tube assemblies for every imaginable purpose. Pictured at the right are some typical examples. We offer you a wealth of experienced engineering assistance and production know-how. Send your blue prints

THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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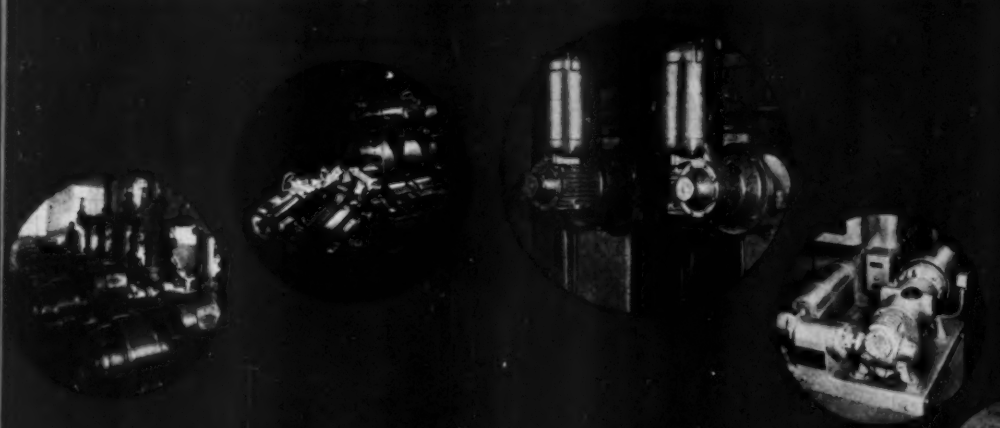


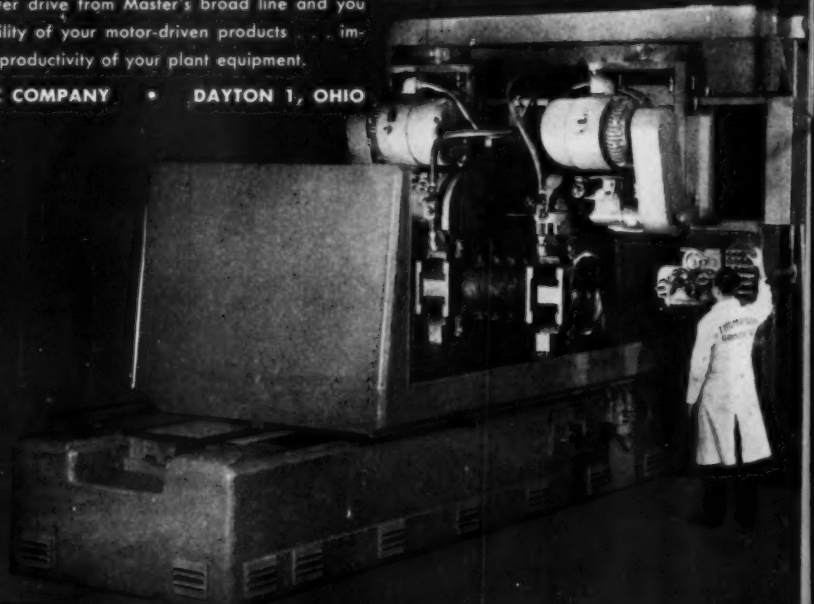
Master Motors, available in millions and millions of types and ratings (up to 150 HP) give you a selection you can get nowhere else. Master has no axe to grind for one type of motor drive over another.

Open, enclosed, splash proof, fan-cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed or variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 432 to 1 ratio . . . with electric brakes . . . with mechanical variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU. So don't put up with make-shift assemblies when it is so easy to get the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

no axe to grind

Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor-driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



AT LAST! 6-Point Recording on a Single Round Chart

Employing only one measuring system, the new Foxboro Multi-Record Dynalog gives up to 6 clean-cut records in as many different colors on one convenient *round* chart. The ingenious, foolproof switching arrangement provides recordings in sequence every 6 seconds—so close that the record of each measurement appears as a continuous line. The record colors positively will not run together.

Like all Dynalog Electronic Instruments, balancing from any measurement point is entirely *stepless* and continuous. Its combination of accuracy, speed and sensitivity is unequalled.

The Multi-Record Dynalog is available for measuring several temperatures or other process variables. Send for Bulletin 428. **The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass., U. S. A.**

UNIQUE ADVANTAGES!

1. Round Chart simplifies operations. You can check records faster, easier and better on the familiar, compact round chart of the new Multi-Record Dynalog. No yards of paper to insert, remove and spread out. Practically continuous lines to follow. Up to 6 distinct colors. Charts occupy less space . . . cost less to use.

2. Round Chart standardizes operations. You can order, stock and use the identical form of chart as used on other types of process instruments.

3. Multi-Record Dynalog saves space.

* Reg. U. S. Pat. Off.

Another FOXBORO FIRST

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DUPONT TETRAETHYL LEAD COMPOUNDS

Piston top deposit, heavy duty, constant speed conditions.

Exhaust valve head deposit, heavy duty, constant speed conditions.

DuPont Research

at Work on the Chemical Nature of Engine Deposits

It has long been recognized that combustion chamber deposits greatly affect fuel performance . . . but little has been known about the relationship between deposit composition and effect on combustion.

As a part of its long-range Petroleum Chemicals research program, Du Pont is making an intensive study of the chemical nature of these deposits, and their effect on fuel performance. By a better and more complete understanding of the over-all deposit problem it is hoped that better scavenging agents or other additives may be developed which will help in the production of improved fuels... today and in the future.

DU PONT

REG. U. S. PAT. OFF.

Better Things for Better Living . . . *Through Chemistry*

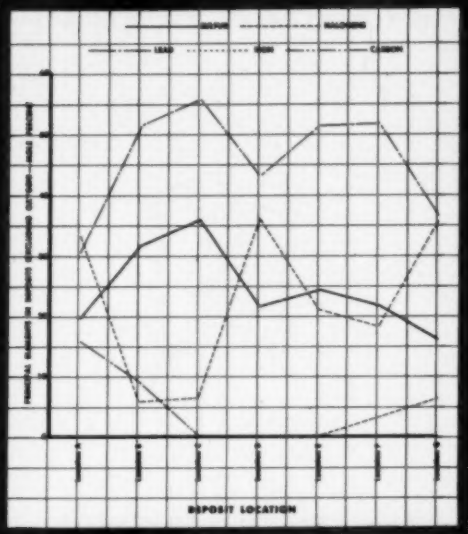
Investigating Engine Deposits for their effect on Fuel Performance

All liquid fuels burned in internal combustion engines produce combustion chamber deposits, the composition of which will vary with the hydrocarbon composition of the fuel, the type of lubricating oil and the presence or absence of tetraethyl lead. Investigation into the composition of deposits from leaded gasolines has shown that in addition to simple compounds they consist of complex mixtures of compounds. Among those definitely identified to date are the eleven listed below.

The most modern X-ray diffraction apparatus and other specialized equipment is used in the analysis of deposits, identifying the different compounds formed under various operating conditions and at various locations within the engine.

This is research upon specific and recognized problems working toward answers which will benefit the entire industry.

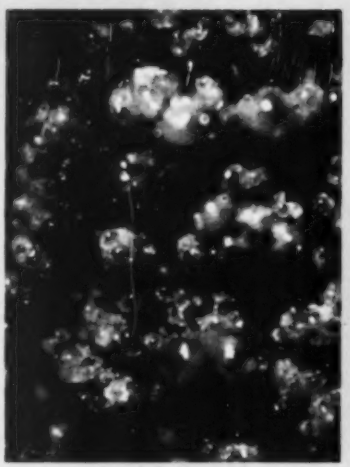
VARIATION IN COMPOSITION OF DEPOSIT WITHIN COMBUSTION CHAMBER OF LABORATORY TEST ENGINE



DEPOSIT COMPOSITION

The following lead compounds are some that have been identified to date in combustion chamber deposits in addition to those contributed by the base fuel and lubricating oils.

PbO
$PbSO_4$
$PbSO_4 . PbO$
$PbSO_4 . 2PbO$
$PbSO_4 . 4PbO$
$PbBr_2$
$PbCl_2$
$PbBr_2 . PbCl_2$
$PbBr_2 . 2PbO$
$PbCl_2 . 2PbO$
$PbCl_2 . PbO$



Photomicrograph of deposit from piston top.

Photomicrograph of deposit from intake valve stem.

DU PONT
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Better Things for Better Living . . . *Through Chemistry*

MAKE DU PONT THE SOURCE FOR ALL OF YOUR GASOLINE ADDITIVES . . .

Tetraethyl Lead Compounds
Motor Mix—Aviation Mix
Antioxidants
Metal Deactivator—Dyes

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
PETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

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- ONLY ONE COAT NEEDED!
- EXTREMELY HIGH ADHESION!
- ADHERES TO BLOCKS, BLANKETS AND CEMENTS!

B-H POWERHOUSE CEMENT... the new finishing cement that insulates

EASY TO APPLY—EVEN OVERHEAD

- HIGH INSULATING EFFICIENCY!
- EASY WORKABILITY REDUCES LABOR!
- LINEAL SHRINKAGE UNDER 1%!
- SMOOTH, HARD SURFACE!
- EFFECTIVE UP TO 1700°

B-H POWERHOUSE CEMENT saves time, cuts costs—a one-coat application trowelled to required thickness in a single operation. Moreover, this new mineral-wool-base finishing cement takes a hydraulic set within two hours.

Its smooth hard finish is paintable. An attractive inside finish can be obtained with *any* paint. Outside, B-H Weatherseal gives permanent protection.

Easy on labor, easy on budget, B-H Powerhouse is the ideal *finishing-insulating* cement for industrial equipment. For full information and free sample, fill out the coupon.

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Please send me complete information on B-H Powerhouse Cement.

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FIRM.....

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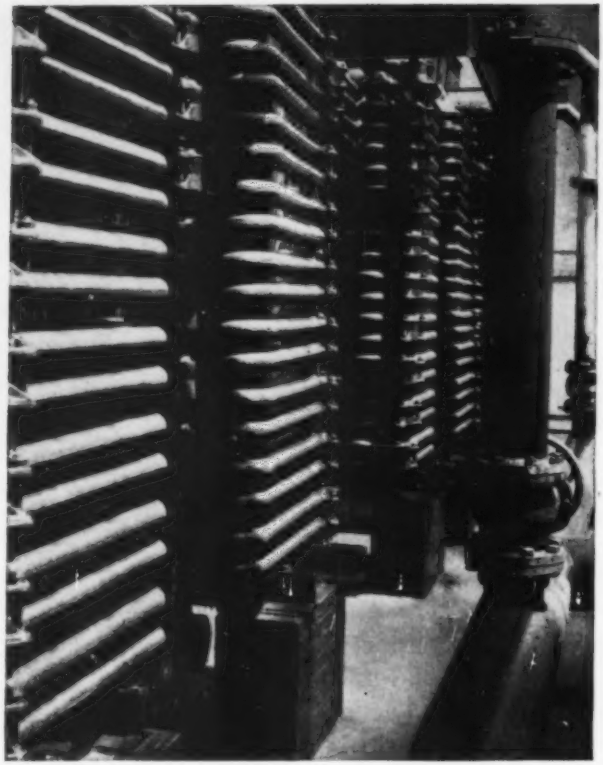
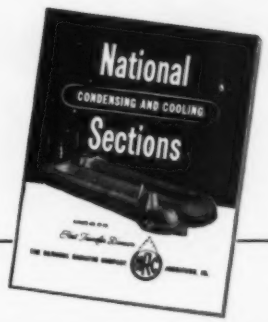


FOR

Performance...

NATIONAL CAST IRON CONDENSING AND COOLING SECTIONS



EFFICIENT Integrally cast longitudinal fins interrupted by swirl stripe increase heat transfer rate, reduce pressure losses. External design promotes unrestricted flow of water with minimum splashing. Far less water is required. In submerged installations, National Sections collect less foreign matter, give high performance longer.

DURABLE Gray cast iron of exceptionally high quality and close grain goes into National Sections. Corrosion resistance under varied and severe conditions is high . . . heavy scaling and growths greatly reduced. Turns reinforced against corrosion. No "battery action" in handling electrolytes.

COMPACT National Sections require far less space for a given amount of heat transfer. In certain installations, National Sections require only one-third the space needed by competitive equipment.

ACCESSIBLE Component parallel stacks of National Sections can be installed, serviced, dismantled easily. Support lugs are cast integrally. Sections are self-aligning, self-supporting—no auxiliary bracing needed.

NEW CATALOG

Installation and Engineering Data

Catalog No. HT-20, just off the presses, gives you full information about the use of National Sections in varied applications. Design features and physical characteristics are explained in detail. Typical installations are pictured and described.

Catalog includes very complete data and curves for pressure drop and heat transfer and should prove a welcome addition to the process engineer's file. Detail drawings of fittings and accessories specially designed for National Sections are shown—along with dimensional data. A simplified data sheet makes it easy for you to request specific engineering information or service.

Write for your copy today.
No obligation of course.

NRC

HEAT TRANSFER DIVISION

THE NATIONAL RADIATOR COMPANY

JOHNSTOWN, PENNSYLVANIA

Your flanged pipe fittings will handle corrosive fluids economically and without interruption —if they are cast of *ESCO* corrosion resisting stainless steel.

For use with common corrosives, *ESCO* standard analyses—AISI types 304, 316, 317 and 347—have proved satisfactory. Special analyses also available include duPont specifications 820A and 820B. To combat unusually severe conditions *ESCO* also offers Alloy 20 (Duriron license). As a permanent identification, the metallurgical type is cast on each fitting.

ESCO flanged fittings are available in 45- and 90-degree elbows, tee, long radius ell, cross, 45-degree lateral, and reducer, from 1-in. to 14-in. Special sizes and shapes produced to order. Faces are accurately machined to insure proper gasket seat. Fittings are rigidly inspected and hydrostatically tested.

Ask for Fittings Catalog

The complete line of *ESCO* pipe fittings is shown with specifications in catalog 165-Ar. Your nearest *ESCO* representative will gladly give you a copy; or use the coupon. Electric Steel Foundry, 2181 N.W. 25th Avenue, Portland 10, Oregon. Offices in Eugene, Oregon; Chicago; Honolulu; Houston; Los Angeles; New York City; San Francisco; Seattle; Spokane. In Canada, *ESCO* Limited, Vancouver, B.C.

ESCO

STAINLESS STEEL EQUIPMENT FOR BETTER PULP

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2181 N.W. 25th Avenue, Portland 10, Oregon
Please send catalog No. 165-Ar to:

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For Economy and Long Service

specify

Pittsburgh Still Tubes

You get economy with Pittsburgh Still Tubes because the wide range of grades available makes it possible for you to select the most economical grade for the creep strength or corrosion resistance you desire. And, you get long service from any grade of Pittsburgh Still Tubes as they give uniform resistance to heat, pressure, oxidation and corrosion.

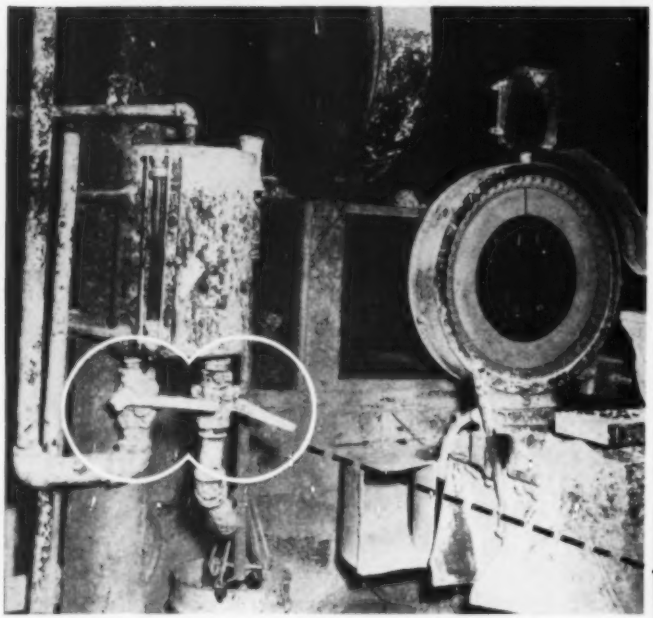
In order to take full advantage of the wide range of analyses ranging from low molybdenum and intermediate chrome-molybdenum alloys to the higher grades, our metallurgical engineers will be glad to help you specify the proper tubes for your next installation. Pittsburgh Still Tubes are made in sizes from 2" to 6" outside diameter (in some cases even larger) and from .134" to 1" average or minimum wall thickness in lengths up to 55' with plain, upset or machined ends. For the greatest economy and longest service in your still tube installations write Pittsburgh Steel Company, Department PR, Grant Building, Pittsburgh 30. Pa.

Mike Mazzei checking size accuracy of machined ends on Pittsburgh Still Tubes.

Pittsburgh Steel Company

OPERATED *350,000 TIMES!*

with NO MAINTENANCE



Libbey-Owens-Ford Glass Company obtains outstanding results with

ROCKWOOD BALL VALVES

Only Valve to Stay in Service Over a Year

Here, in this glass plant, Rockwood Ball Valves are giving *unsurpassed* service under extreme rugged conditions. For over a year, they have been opened and closed over and over again without the need of maintenance.

The two 1½" Rockwood Valves shown above are used on river water to mix plaster for the Grinding and Polishing line. Both Valves are worked 24 hours a day, 5 to 6 days a week and are operated approximately 1500 times a day depending on line speed. Company official says, "We are very well pleased with their operation; the best service we could get from other makes of valves prior to this was 6 to 8 weeks."

This plant is only one of many that is getting outstanding results from Rockwood Ball Valves. Place your order today for the new Rockwood Ball Valve.

For additional information and uses, write for bulletin V-4 today.

FULL ROUND FLOW! LEAK PROOF SERVICE!

To ensure top performance, Rockwood engineers designed the Rockwood Ball Valve with these 7 outstanding features. 1. Full round open area — no turbulence in fluid stream. 2. Leak proof after continued use. 3. Floating ball — resists pitting, scratching and abrasion. 4. No exposed seating surface in open or closed position. 5. Easy to open or close under full pressure. 6. Installed in any position. 7. Quarter turn (90°) opening and closing valve.

Rockwood Ball Valves are available in bronze from ½" to 2" for 300 p.s.i. working pressure and are recommended for use on lines handling water, air, gas, petroleums, food, carbon dioxide, nitrogen, paraffin and asphalt base petroleums, also alcohol, paper fluids and other types of liquids and gases.

Distributors in all principal cities.

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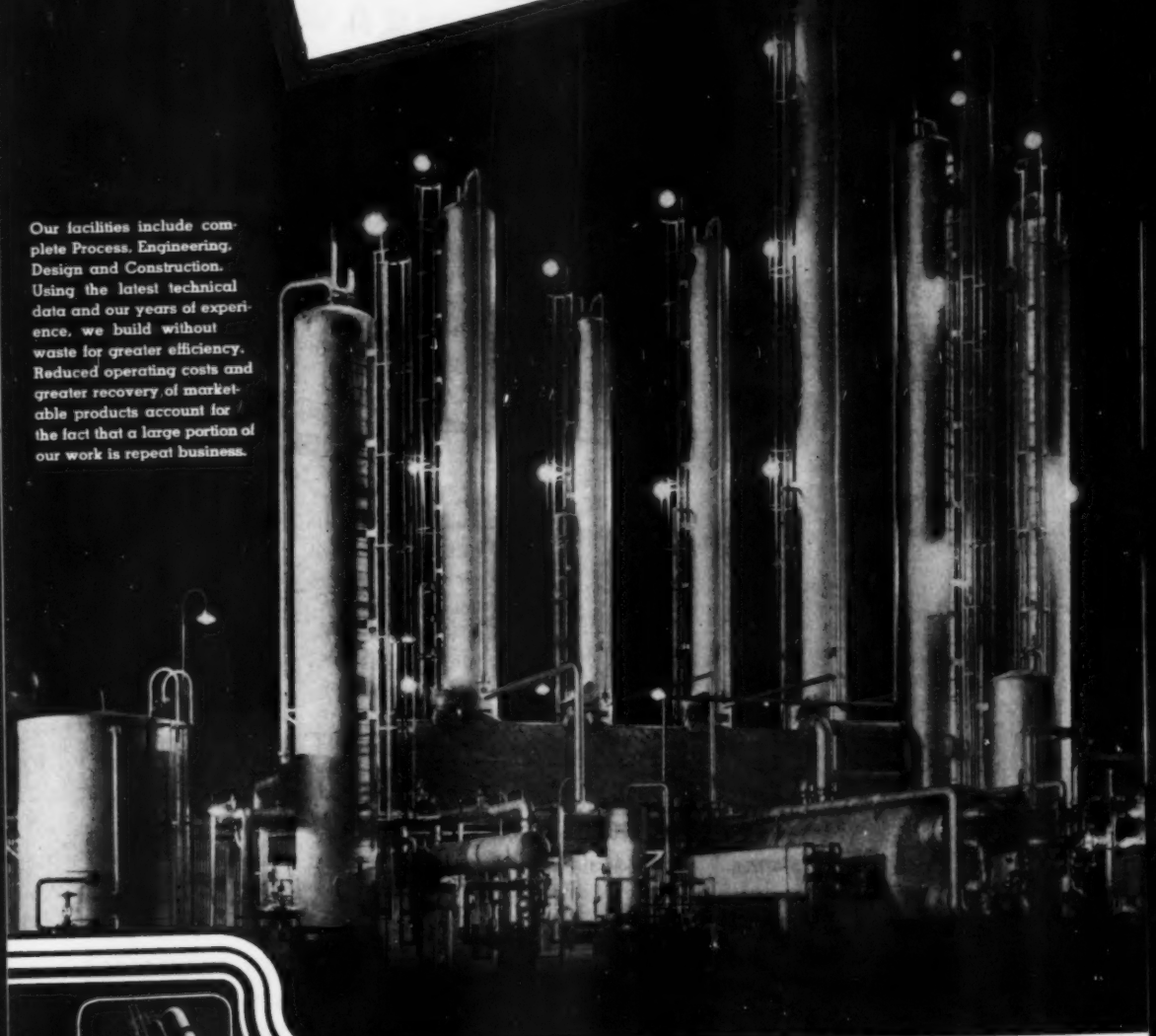
Greater EFFICIENCY
Less INVESTMENT

Our facilities include complete Process, Engineering, Design and Construction. Using the latest technical data and our years of experience, we build without waste for greater efficiency. Reduced operating costs and greater recovery of marketable products account for the fact that a large portion of our work is repeat business.



Engineering and Construction Division

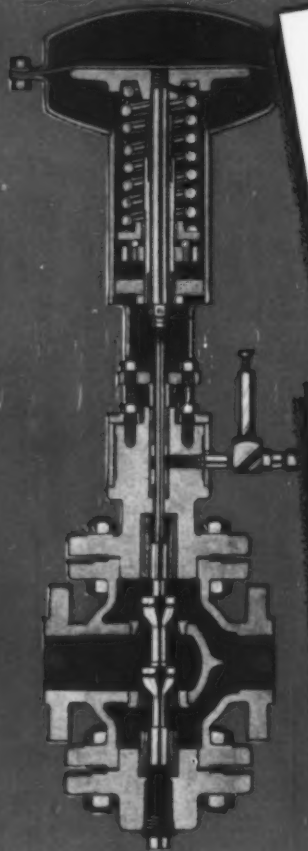
JONES & LAUGHLIN SUPPLY COMPANY

TULSA, OKLAHOMA

AUTOMATIC CONTROL EQUIPMENT

ENGINEERED DESIGN BY **HAMMEL-DAHL**

FLO-TESTED*

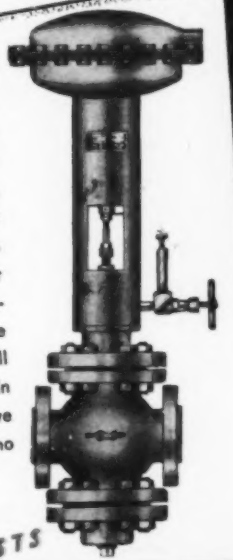


DIAPHRAGM *Control Valve*

3000 SERIES

These Standard Control Valves are designed for use with air operated instruments for control of pressure, temperature, liquid level, rate of flow, humidity or pH. They can be applied with equal efficiency on air, water, steam, oil or gas service and are available in sizes from ½" to 12".

The ALLSTEEL Superstructure is fabricated from 3/16" steel stampings. Oilite Bearings eliminate spring stem friction. Stainless steel spring stem standard. Packing box bolted on all size valves. Bonnets and blind heads are forged fabricated. Bonnet will support ALLSTEEL Superstructure if installed horizontally. They are through-bolted for greater strength and also to provide simplicity of field reversal. Valve bodies have ASA Standard Face to Face dimensions. All valve plugs are top and bottom guided in hardened stainless steel bushings. Valve action reversible in the field, requiring no additional parts.



FAMOUS *Hammel-Dahl* FIRSTS

Visit our Booth 210 at the Conference and Exhibit of the **INSTRUMENT SOCIETY OF AMERICA** *Municipal Auditorium, St. Louis September 12 thru 16*

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HAMMEL-DAHL COMPANY

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ALBANY BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DETROIT
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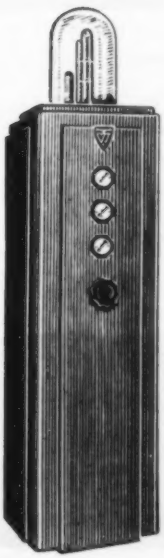
SEATTLE ST. LOUIS SYRACUSE TOLEDO TULSA WILMINGTON, DEL.

In Canada, Railway & Power Engineering Corporation, Ltd.

APARTMENT FOR SLIME

With condenser tubes handling unchlorinated water, slime-forming bacteria never have to worry about a housing shortage. Instead, these bacteria move in, form their colonies, and the condenser tubes become apartments for slime. When this happens, the terminal log mean temperature difference rises, excess steam costs go up, and outage increases along with the labor bill for costly plug cleaning.

Chlorination, engineered by W&T and backed by 35 years' experience, has proven itself the effective answer to slime in condenser and heat exchanging equipment. It is effective because the Wallace & Tiernan De-Sliming Process attacks the cause of slime, bacteria, and "evicts" these unwanted "tenants" from their home in your equipment.



CD-32

Regardless of whether yours is an open or closed cooling system or whether you use shell and tube, trombone, or open box condensers, Wallace & Tiernan engineering plus time-tested W&T Chlorinators can put all the money-saving advantages of slime control by chlorination to work on your condensers or heat exchange equipment.

Write today for complete information.

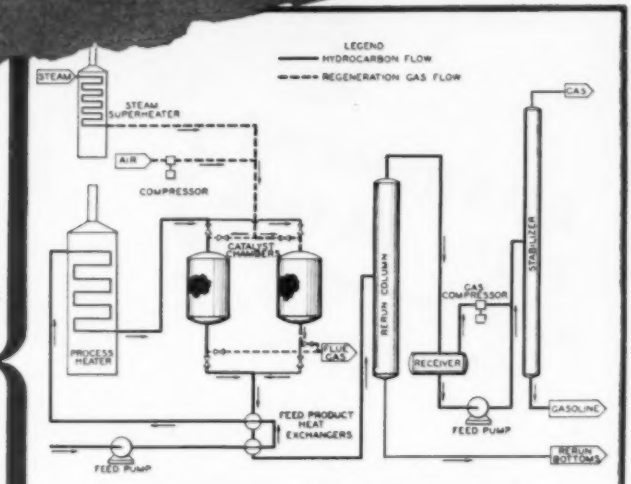
WALLACE & TIERNAN PRODUCTS, INC.

CHLORINE AND CHEMICAL CONTROL EQUIPMENT

Belleville 9, New Jersey • Represented in Principal Cities

Reform *your Condensate Gasolines*

with Perco* Cycloversion* Catalytic Reforming



From the new 28 page book, "Pointing the Way to Profits with Perco Processes." Copies mailed on request.

Increase the Research Octane Rating of Cycling Plant or Condensate Gasolines as much as ten numbers at the 3 cc TEL level, with high yields.

Install a Perco Cycloversion Catalytic Reforming Unit, the process that has been proved by actual construction and operating experience.

A Perco engineer will gladly explain the outstanding benefits you may receive from a Perco application in your plant.

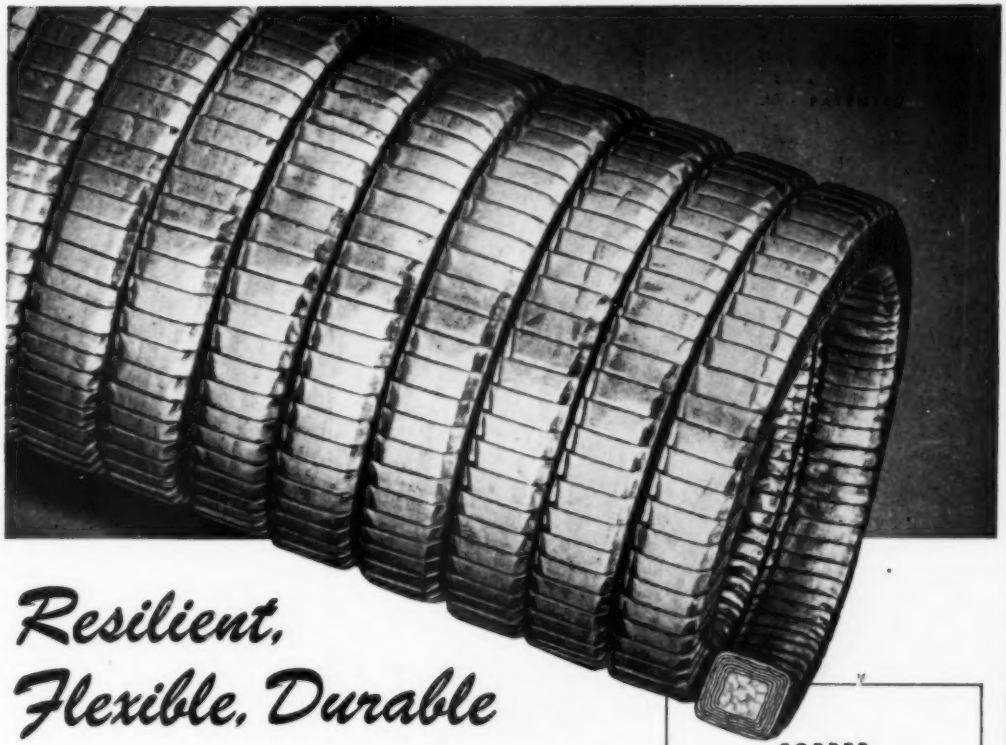
*A service mark

Phillips Petroleum Company

PERCO PROCESSES

PERCO DIVISION • CHEMICAL PRODUCTS DEPARTMENT
BARTLESVILLE, OKLAHOMA

PROFIT WITH PERCO PROCESSES



Resilient, Flexible, Durable

YOU LIKE fibrous packing because it is resilient; and you like metal packing because of the durability of the metal wearing surfaces in contact with the rod or shaft.

To give you *both* of these desirable qualities, Garlock has developed a new line of Metal Foil Packings by wrapping a thin metal foil spirally around a fibrous center core.

A patented, pleated foil construction used in several of these new Garlock packings imparts unusual flexibility to the packing and permits the forming of rings without undue distortion of the material. Also the many small pockets in the pleats or folds of the foil carry lubricant or graphite to the wearing surface of the packing.

Garlock Metal Foil Packings are recommended for centrifugal or reciprocating pumps, compressors, engines, expansion joints, etc. Write for descriptive folder.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
Tulsa, Okla. Houston, Texas Los Angeles, Calif.

COPPER

GARLOCK 906—Pleated copper foil with asbestos core for steam, air or gases (except ammonia) and hot oils of low sulphur content, at temperatures up to 1000° F.

ALUMINUM

GARLOCK 913—Pleated aluminum foil with asbestos core for hot oils at temperatures up to 1000° F.

LEAD

GARLOCK 917—Pleated lead foil with asbestos core for steam, air, oil, water, ammonia or other gases at temperatures up to 550° F.

GARLOCK METAL FOIL PACKINGS

How far can you go in searching out an economical, positive solution to every refining problem? Can you afford, in terms of time and manpower, to get *all* the facts in every case . . . even when you are faced with several major problems at one time?

UOP

American Liberty Adds 10% to Gasoline Yield

By A. C. Johnson

Assistant Superintendent
American Liberty Oil Company
Mount Pleasant Refinery

An increase of about 10 percent in the overall gasoline production of our Mount Pleasant refinery has been realized without running additional crude by the installation of a non-selective catalytic polymerization plant. This unit utilizes UOP solid phosphoric acid polymerization catalyst for converting the propylenes and butylenes in the total cracking plant gas to hydrocarbons boiling in the gasoline range.

A. C. Johnson

A poly plant was first planned in 1941, but consideration was dropped during the war when practically all of our output was directed to the manufacture of fire bombs.

Because of vastly improved markets and the need for higher octane numbers, the project was revived in 1946 and Universal Oil Products Co. was asked to make a survey. As a result, UOP was called upon for all design and processing work, while American Liberty engineers conducted all architectural and layout work with UOP acting as consultant. All new vessels except the catalyst case and deethanizer tower were fabricated by the refinery with existing equipment being used wherever possible.

Design Capacity 2,160,000 cu. ft.

The design capacity of the poly unit is 2,160,000 cu. ft. of fresh cracked gas per day representing the total gas produced by the UOP thermal cracker. The quantity of polymer gasoline produced depends upon the amount of gas available for processing, and this in turn, depends upon the operating schedule of the cracking plant. At design capacity, the poly unit will produce 235 b/d of 10 pound polymer gasoline. During the past year, however, it has been advisable to operate the cracking plant for maximum throughput of gas oil rather than for maximum yield which has limited the poly yield to an average of 170 b/d.

Shut down on April 4 of this year, after its first run of 195 days actual on stream time, the poly unit showed a total output of 1,263,765 gal. or 81 gal. per pound of catalyst.

The polymer gasoline produced has a clear Motor Method and a clear Research Method octane number of 82.5 and 97 respectively with blending values substantially higher. The high octane blending value, both motor and research, makes this product very valu-

able in raising the overall level of the refinery's gasoline. By blending with cracked gasoline and selected straight run materials, the octane rating of premium gasoline can be raised two octane numbers, or a given octane reached with approximately half the lead formerly required.

Gas from the cracking plant absorber is compressed in the low stage of the compressor, and together with the high pressure gas from the cracking plant stabilizer, is sent to the treating section operating at 150 psi. Having about 1,200 grains of H_2S per 100 cu. ft. and fairly high mercaptan content, the gas first enters the Girbitol unit where H_2S is removed down to 25 grains. In the H_2S scrubber the last traces are removed by caustic. Mercaptans are extracted in a regenerative caustic system.

The sweet gases are then compressed in the high stage to 500 psi, and heated to 380° F. by first exchanging heat with catalyst tower effluent and then through a heater using hot oil from the cracking unit as a heating medium. The hot gas enters the top of the catalyst chamber where contact is made with the catalyst, which is arranged in five beds with a total charge of 15,000 pounds. Proper hydration of the catalyst is controlled by the addition of water and the reaction temperature of each bed is controlled by using liquid propane as a quench.

Operating Data

Operating data for the catalyst tower is as follows:

Pressure, psi	450
Temperature, Gas in, °F.	380
Temperature, 1st Bed, °F.	410
Temperature, 2nd Bed, °F.	420
Temperature, 3rd Bed, °F.	425
Temperature, 4th Bed, °F.	430
Temperature, 5th Bed, °F.	435

After the polymerizing action of the catalyst, the effluent from the catalyst chamber is cooled and gas is removed from top of the catalyst tower effluent receiver. This gas goes to the poly absorber where recoverable light ends are picked up and returned to the cracking plant fractionator. The liquid from the receiver is then charged to the deethanizer.

With adequate cooling and subsequent low deethanizer receiver temperature, maximum propane recovery is possible. A small amount of propane, together with the ethane and lighter gases, is taken overhead to fuel, and bottoms are charged to the depropanizer. The depropanizer, operating at 275 psi produces specification propane overhead, the bottom being charged to the debutanizer. From the bottom of this vessel poly gasoline at specified Reid vapor pressure is removed with all excess butane going overhead to storage.

Today the American Liberty Mount Pleasant Refinery has a crude capacity of 13,000 barrels, thermal cracking capacity of 4,000 barrels, and facilities for the manufacture of asphalt and special naphthas, as well as the new poly unit.

You have to dig deep

Successful refining demands that you dig deep for facts and solutions, regardless of the size of your staff or the time available. That's why refiners depend on Universal service. It's their assurance of help in finding the answers to technical, physical and economic problems . . . especially when they need help in a hurry.

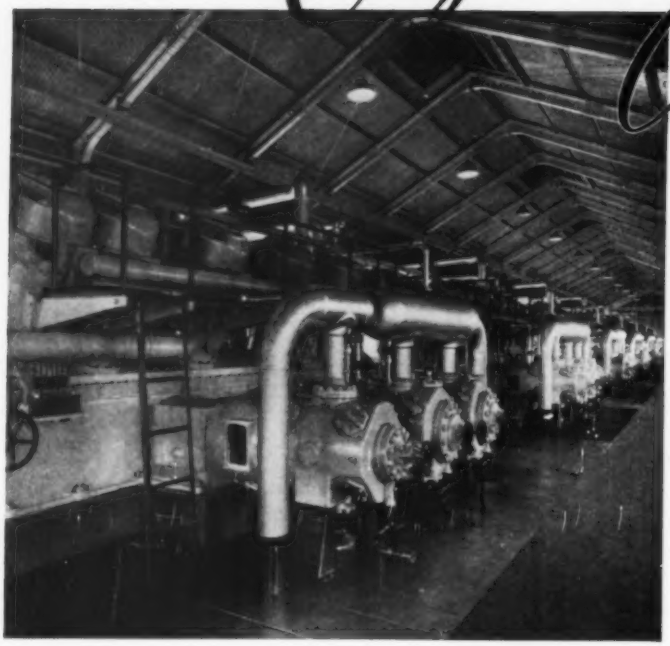
UNIVERSAL OIL PRODUCTS COMPANY

UOP

General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILLINOIS, U.S.A.
LABORATORIES: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

BACK OF *Every* INGERSOLL-RAND *Compressor* ARE THESE *Sup*R*values*



This 7000-hp installation of Ingersoll-Rand KVG 4-cycle V-angle gas-powered compressors serves a natural-gas conservation program. The gas is gathered from producing oil wells and stripped of its liquid content. The high-pressure residue gas is then distributed to industrial centers where it is fully utilized.

KVG compressors are highly standardized in a full line of sizes from 600 to 1200 hp using interchangeable power cylinders. Each installation is specially engineered to obtain a combination of the size of unit and the proper compressor cylinders that will result in the highest degree of operating flexibility, economy, and reliability.

For your petroleum and chemical processes it pays to choose compressors backed by *Sup*R*values* . . . That's why Ingersoll-Rand can help you.

- **Tradition**...a 77-year old company that grew from the *two of the earliest* compressor builders in America.
- **Experience and Know-how** to build compressors for *any* pressure, *any* gas, *any* size, *any* service.
- **Facilities** *second to none*... for design, research, metallurgy, and manufacture.
- **Range of sizes** . . . with *standardized* frames, running gears and interchangeable cylinders ...plus *special* cylinders, valves and coolers for special applications.
- **Flexibility of Drive** . . . a *choice* of compressors powered by electric motor, oil, gas, or steam.
- **Record of Performance** ...thousands of compressors successfully operating in *every* branch of industry.
- **Design Features** that give you the best in efficiency, durability, dependability, easy operation, and low maintenance.
- **Trained Personnel** ...men who *know* Air Power...who build, sell, and service air drills and tools as well as compressors.
- **Progressive Policy**...*continuous* pioneering and development of both new and old products.
- **Service** ...with offices in principal cities *all over the world.*

Ingersoll-Rand

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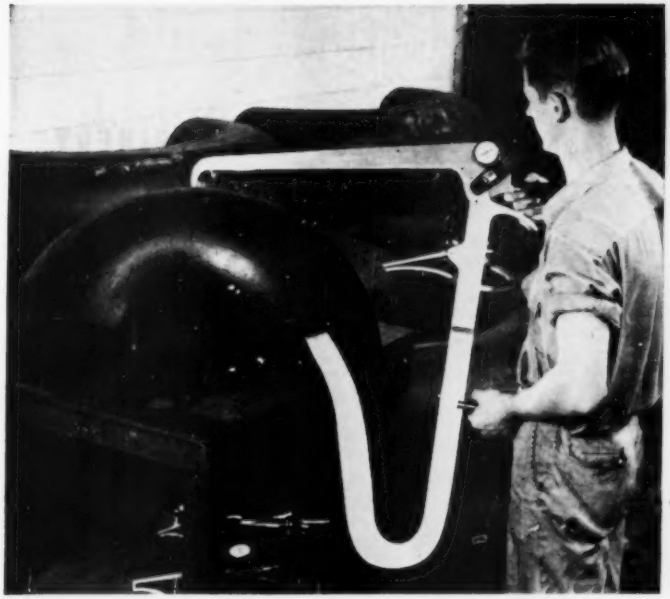
COMPRESSORS • ROCK DRILLS • AIR TOOLS • BLOWERS • PUMPS • ENGINES • HOISTS • VACUUM EQUIPMENT



TUBE-TURN

tt

WELDING FITTINGS AND FLANGES

Precision through Care in Tube-Turn welding fittings

"Mike" checks 'em all!

THE wall thickness of Tube-Turn welding fittings simply has to be right. Every single Tube-Turn welding fitting is micrometer-checked before being put on the market.

Instruments of exclusive design do the trick. They measure wall thickness at the center of an elbow or 180° return as easily, accurately as at any other point. Whether it's ten, a hundred, or a thousand, the Tube-Turn welding fittings you buy are properly matched to pipe of corresponding size —at the face and throughout the fitting. Cut a Tube-Turn welding elbow to any odd angle required. It still lines up.

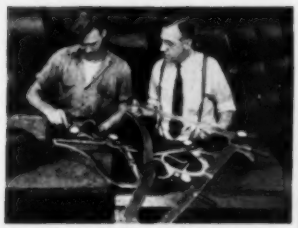
This micrometer check for dimensional accuracy is a small part of the thorough scrutiny to which the finished Tube-Turn product is subjected.

More than thirty skilled inspectors check for true circularity, accurate center-to-face dimensions, uniformity of curvatures, soundness of outside and inside surfaces, wall thickness of butt ends, bevels, lands, and quality of machining.

And that's just a fraction of the total *care* involved in the manufacture of Tube-Turn welding fittings.

Perfection begins with the raw material which is checked for conformity to required chemical composition and physical properties. It must pass all pre-determined requirements before acceptance for production of Tube-Turn welding fittings. Special materials, of course, undergo special tests.

When you buy "Tube-Turn" you want good connections. That's what you get, every time.



Five different-size gauges of exclusive design are used to check the wall thickness of every Tube-Turn welding fitting.

While one inspector checks the diameter of a 90° elbow, the other checks on perfection of inner wall.

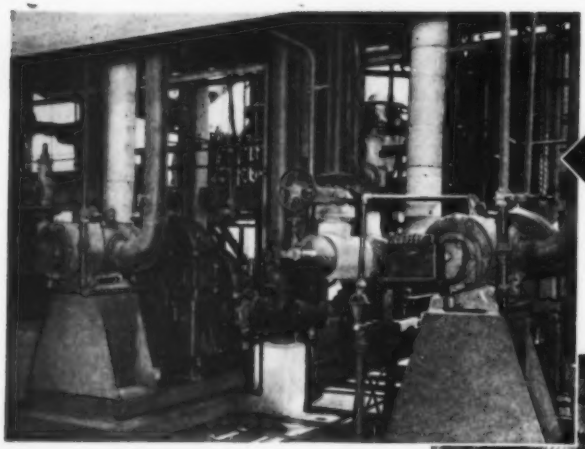
Inspectors check the center-to-face dimension of a 20°-90° Tube-Turn welding elbow.

A part of the final inspection department. Here, Tube-Turn welding fittings undergo intensive instrumental and visual inspection.

TUBE TURNS, INC.

244 East Broadway, Dept. I, Louisville 1, Kentucky

District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, Tulsa, San Francisco, Los Angeles

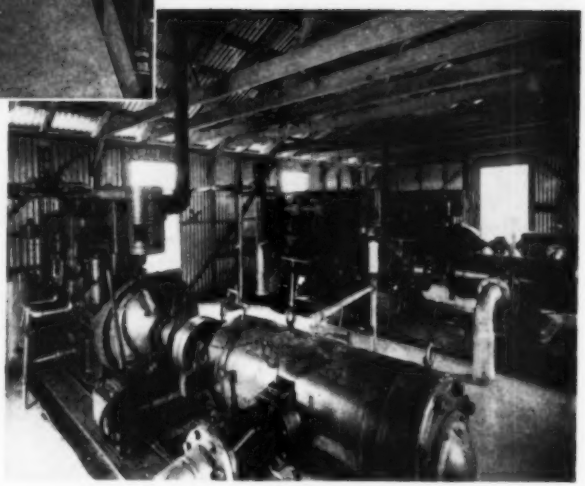


IN THE REFINERY

Two of six Fuller Rotary Single-stage Compressors in a refinery. Capacity each, 475 c.f.m., 45-lb. pressure. Turbine drive.

IN THE FIELD

FULLER ROTARY COMPRESSORS ARE EFFICIENT AND DEPENDABLE



Three Fuller Rotary Single-stage Compressors, applied to boosting of natural gas. Capacity each 1,430,000 cu. ft./24 hrs., from 5-lb. gage to 25-lb. Natural gas-engine drive.

Fuller Rotary Compressors, in the refinery for general plant air, purging gas, refrigeration in alkalization units, and handling butane-butylene, as well as in the field for pressure boosting and gas gathering, have proved their worth, as is evidenced by the hundreds of these machines in use throughout the industry.

The ability of Fuller Rotary Compressors to perform, day in and day out, with minimum attention and maintenance, has earned for them a well deserved position in the oil fields. Particularly adapted to handling of weak wells, and the volumes demanded, without creating a serious maintenance problem, they have proved to be an economic and practical answer to diminishing pressures. Their flexibility and low cost make them adaptable to varied conditions.

It will pay you to become acquainted with Fuller Rotary Compressors and Vacuum Pumps. We'll be glad to send you Bulletin C-5, describing these machines.

FULLER COMPANY
CATASAUQUA—PENNSYLVANIA

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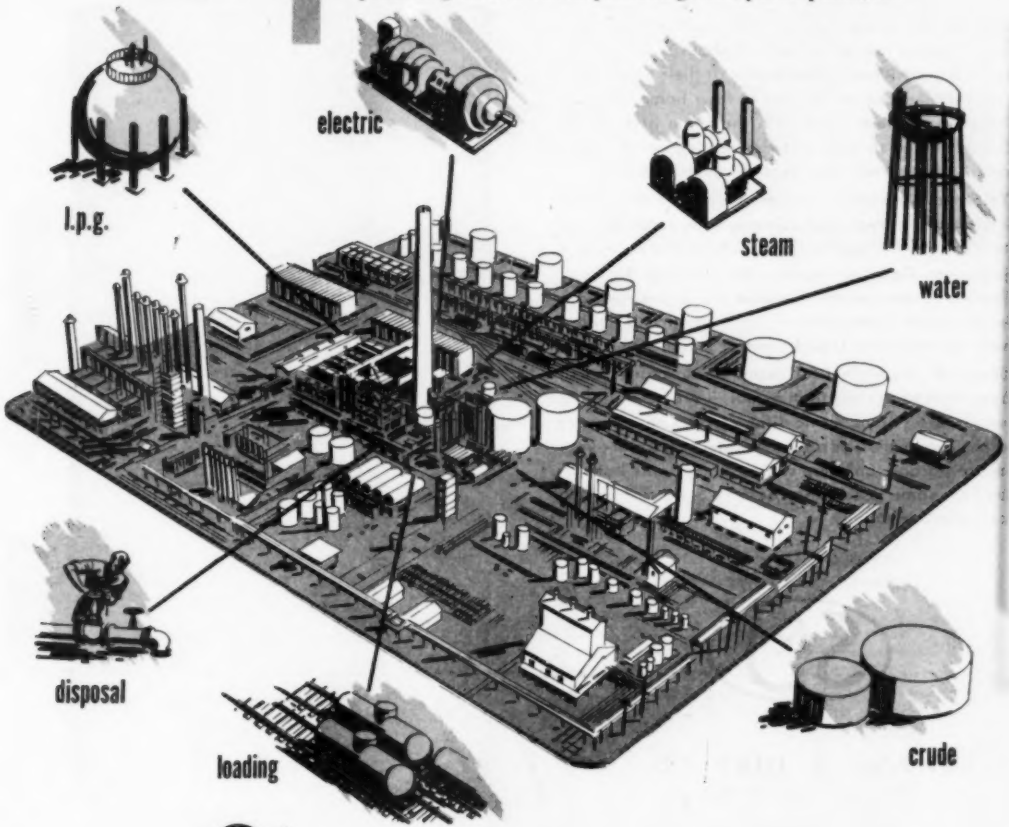
FULLER A LIFETIME OF NEW MACHINE EFFICIENCY

C-186

Fluor designs off-site facilities too

Whatever your Off-Site requirements—balanced steam and electrical systems . . . interconnecting process piping and rack structures . . . water disposal and fire protection systems . . . roads, rail spurs and loading racks for product handling . . . warehouses and tank farms for storage—Fluor will design, construct and install these facilities for maximum efficiency and economy.

Experienced Fluor Engineers, together with permanently employed Fluor key construction personnel, are available to handle any or all Off-Site Facility work necessary for successful on-stream operation of refineries, gas-gasoline processing units, chemical processing units, power plants, etc.



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FLUOR

BE SURE WITH FLUOR

Fluor's combined engineering and construction service relieves plant operators from periodically building up large temporary construction staffs and effects large savings and reduces administrative problems.

Designers and Constructors of Refinery, Chemical and Natural Gas Processing Units.
Manufacturers of Cooling Towers, Fin-Fan Units, Mufflers, Gas Cleaners and Pulsation Dampeners.

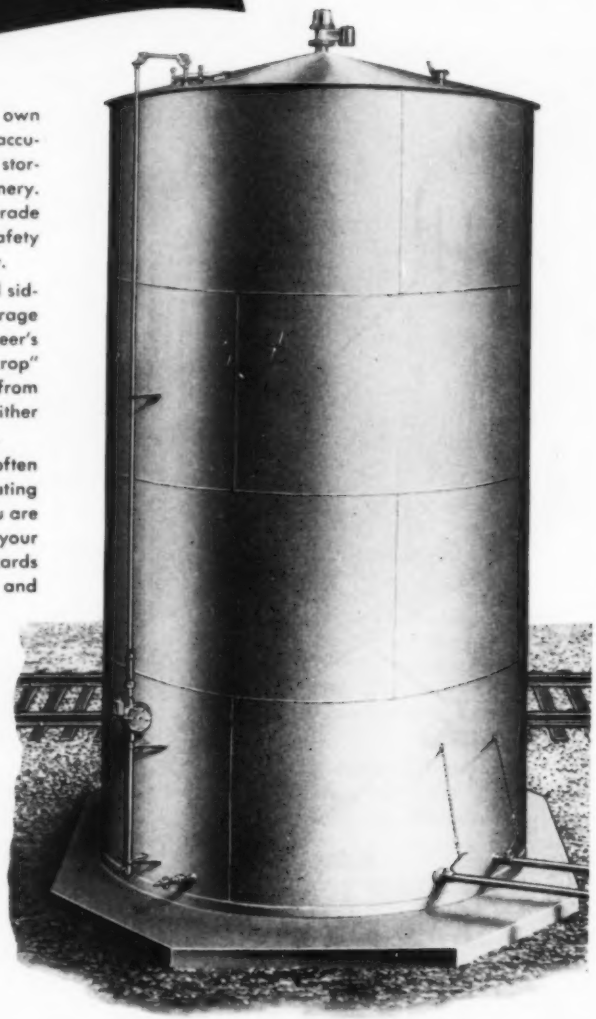
THE FLUOR CORPORATION LTD. *Los Angeles 22* • NEW YORK • CHICAGO • BOSTON • PITTSBURGH • TULSA • HOUSTON • SAN FRANCISCO

DEPOT STORAGE TANKS *Deserve* S & J Fittings

Most of the major refiners who market their own products are just as concerned about safety, accuracy, economy and conservation at their depot storage installations as they are at their home refinery. They equip these tanks with the same high grade S. & J. fittings to obtain the same degree of safety and economy that they demand at the refinery.

Yet, across this great land are thousands of rail sidings in small towns and villages, with depot storage tanks whose fittings are not a credit to any engineer's judgment. Gasoline vapors—"the cream of the crop"—are dissipated to the thin blue air. Shrinkage from evaporation is tremendous. Tank gauging is neither safe nor accurate. Liquid transfer is dangerous.

Shand & Jurs fittings for depot storage tanks often save their cost in less than a year, just by eliminating vapor losses. It makes no difference whether you are a big corporation or an independent operator—your depot storage tanks are subject to the same hazards and the same losses—they deserve S. & J. safety and conservation fittings.



S&J

SHAND & JURS CO.
BERKELEY, CALIFORNIA

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SHAND & JURS

In case of emergency, BJ will fly engineers, repair crews, and equipment to your operation.

ARE YOU TAKING ADVANTAGE of the services offered by BJ in keeping pump performance at "peak" levels? Whether for design, installation, maintenance, parts replacement or for an analysis of your pump needs — BJ offers you the advantages of a sound service program and a pioneer background in the successful application of centrifugal pumps.

CALL your local BJ Representative if a service or installation problem is confronting you. Or write direct for specialized engineering assistance.

BJ

SERVICES PROMOTE EFFICIENCY IN YOUR PLANT

- 4 strategic factory locations: Bethlehem, Pa;. Houston, Tex.; Los Angeles, Calif.; Fresno, Calif.
- Service Departments within each factory organization
- Specialized engineer-designer assistance
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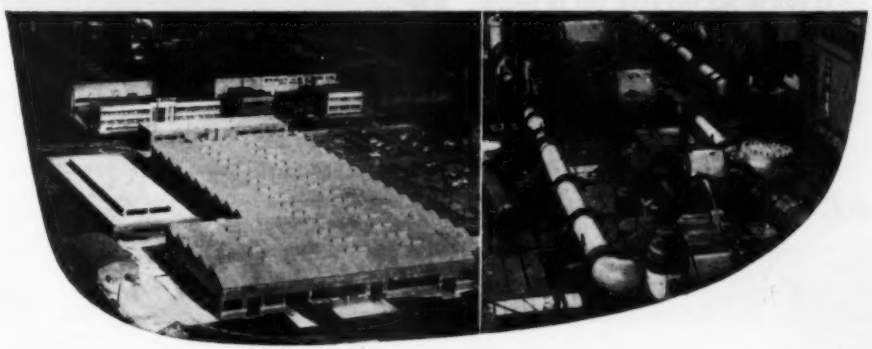
- Factory and Dealer sales and service organizations
- Half-million-dollar Hydraulic Testing Laboratory— the world's most modern
- Quick emergency services possible with company-owned airplane

Byron Jackson Co.
Since 1872

LOS ANGELES 54, CALIFORNIA • *Offices in principal cities*
Plants: Los Angeles • Bethlehem • Houston • Fresno

Air view of the modern Byron Jackson Los Angeles Plant—completed in 1946. The capacities of this new Plant are complemented by the other three BJ Plants.

The new Testing Laboratory offers you the most modern pump-testing facilities. Here—the design, workmanship, reliability of assemblies, and actual operating efficiencies of BJ Pumps are conclusively tested before shipping.



PAGE WELDING ELECTRODES AND GAS WELDING RODS

WELDING STAINLESS?

○

TO RESIST WHAT?

HEAT?
COLD?
IMPACT?
BENDING FATIGUE?
CORROSION?
WHAT **KIND** OF CORROSION?

○

NOW ONE MORE QUESTION:

Are you using the best electrode or rod for your purpose?

If you're not too sure, get in touch with your PAGE distributor. Either he knows or he can find out from the PAGE Field Service Man. And the PAGE distributor has a wide selection of Page-Allegheny Stainless Steel rods and electrodes, so that he can give you the one that will serve you best.

ACCO

Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, Portland, San Francisco, Bridgeport, Conn.

PAGE STEEL AND WIRE DIVISION
AMERICAN CHAIN & CABLE

Get in touch with your PAGE Distributor

Selectivity!

Efficient H_2S removal in the presence of CO_2

The Shell Phosphate Process for gas or liquid purification has undergone successive improvements since its unusual advantages were first discovered.

Now it is practicable to remove all but harmless amounts of H_2S in the presence of large volumes of CO_2, while most of the CO_2 is left untouched.

The treating agent is inorganic, low in cost, and is not soluble in hydrocarbons. Since hydrocarbons being treated are not contaminated by the Shell Process treating solution, there are no harmful effects upon subsequent processing.

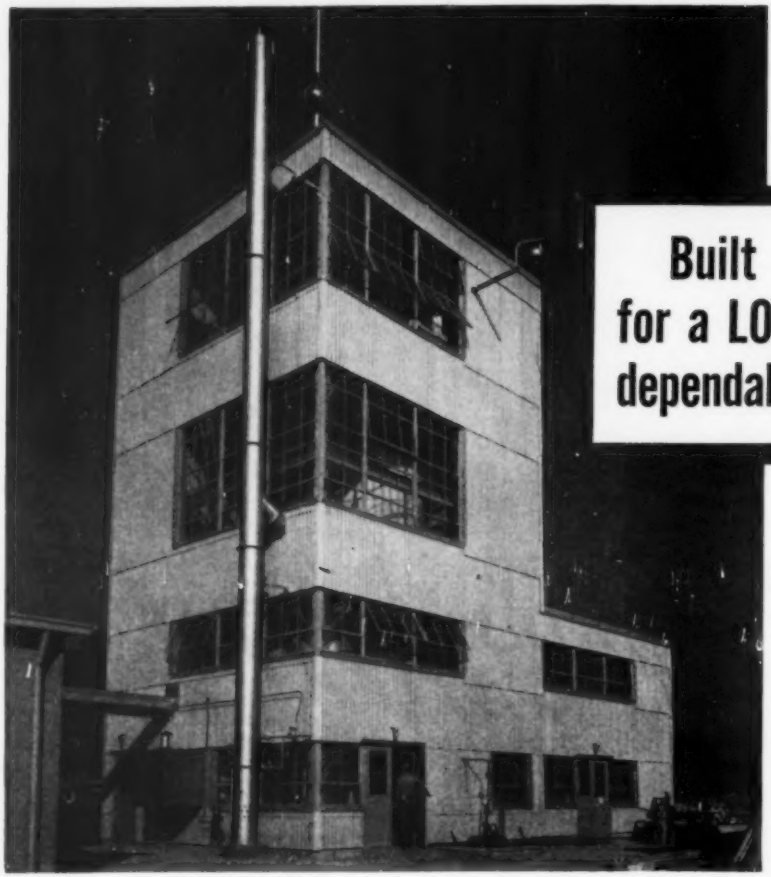
Regenerated H_2S is relatively pure because of its preferential removal in the first place . . . and because the inorganic treating chemical, having no vapor pressure, cannot contaminate the H_2S released in the stripper.

The Shell Phosphate Process is available to any operator under license from the Shell Development Company, Incorporated . . . together with experienced engineering service for its design, installation, and operation. Write for complete information.

SHELL DEVELOPMENT COMPANY, INCORPORATED

50 West 50th Street, New York 20, N. Y.

• *New pilot plant of Pittsburgh Consolidation Coal Company at Library, Pa., sided with "Century" Asbestos Corrugated. Construction by Chemical Plants Division of Blaw-Knox Company, Contractors.*



Built for a LONG life of dependable service

K&M "Century" ASBESTOS CORRUGATED

Nature made Asbestos...
Keasbey & Mattison has made it serve mankind since 1873

This large pilot plant of the Pittsburgh Consolidation Coal Company is the latest unit in one of the most modern research laboratories of its kind. The new building is designed and equipped for the study and development of more efficient coal gasification processes.

It is fitting that the fine equipment of this pilot plant should be housed in a modern building sided with good-looking, long-lasting K&M "Century" Asbestos Corrugated. This time-proved material is noted for great structural strength and ability to withstand severe commercial usage. It resists fire, weather, rot, rust and galvanic action. And no protective painting or upkeep is needed.

"Century" Asbestos Corrugated is easy to cut with a portable electric or band saw . . . easy to drill . . . easy and *fast* to apply, for it comes in 24 different sheet lengths. Can be re-used even after many years of service.

Write for name of nearest distributor and further particulars. Your inquiry will receive prompt attention.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

REFINERY EQUIPMENT...

designed and fabricated to specifications of customers' needs. Pictured is low pressure absorber with stripping tower in back, fabricated for an important oil company. You are invited to consult our engineering department on your fabrication problems.

WRITE FOR OUR COMPLETE CATALOG

201-5 W. Commerce Street • P. O. Box 5387
DALLAS, TEXAS

L7 A Husky Steel

for Low-Temperature Bolting

When refinery engineers encounter bolting conditions with temperatures as low as −150 F, they can count on Bethlehem fastenings made from Bolting Grade L7. For at this low temperature, L7 offers minimum impact strength of 15 ft-lbs. It's a husky through and through—a heat-treated alloy steel which has been specially developed for the manufacture of studs and bolts for service at sub-zero temperatures. It conforms to ASTM Specification A320—48T, and fulfills the following chemical and tensile requirements:

L7—CHEMICAL REQUIREMENTS

	RANGE	Check Variation Over or Under *
Carbon, pct	0.38 to 0.45	0.02
Manganese, pct	0.75 to 1.00	0.04
Phosphorus, pct	0.040	0.005 over
Sulphur, pct	0.040	0.005 over
Silicon, pct	0.20 to 0.35	0.02
Chromium, pct	0.80 to 1.10	0.05
Molybdenum, pct	0.15 to 0.25	0.02

**Unless otherwise specified, separate determinations may vary from the specified ranges, except that elements in any heat must not vary both above and below the specified range.*

L7—TENSILE REQUIREMENTS

Diam, In.	Tensile Strength min psi	Yield Point min psi	Elongation in 2 in. min pct	Reduction of area min pct
2½ and under	125,000	105,000	16	50
Over 2½ to 4 incl.	105,000	80,000	20	50

Grade L7 fastenings can be obtained in short order, because the steel from which they are made is a stock item with Bethlehem. They are recommended for use with the Bethlehem Grade 4 carbon-molybdenum nut, also carried in stock. Bethlehem also produces a wide range of steels for use in high-temperature bolting.

Along with its fully-equipped fastenings plant at Lebanon, Pa., Bethlehem has an engineering staff which is available to work with you in solving virtually any low-temperature or high-temperature fastenings problem that comes along. So put your fastenings needs up to us . . . today, tomorrow, any time.

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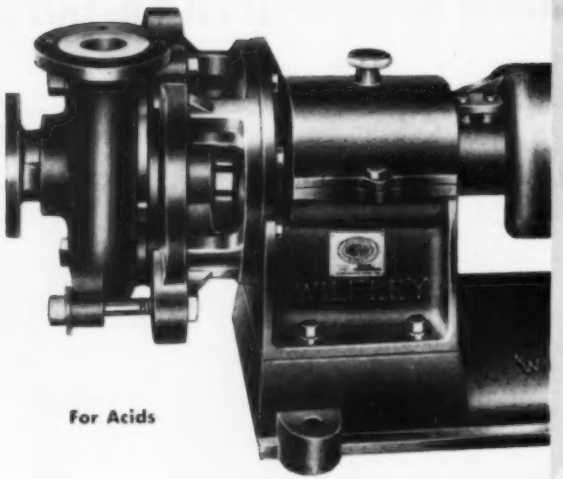

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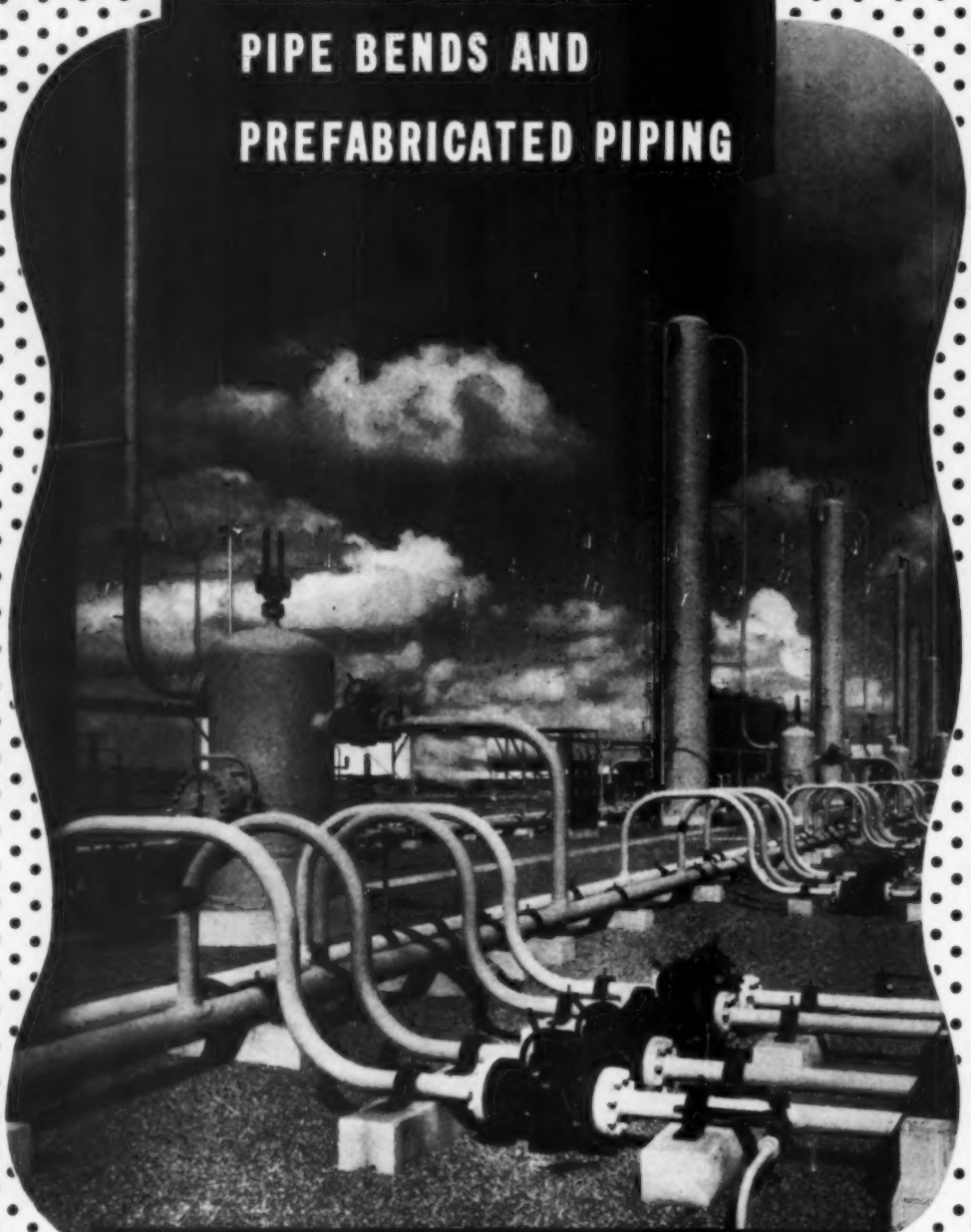

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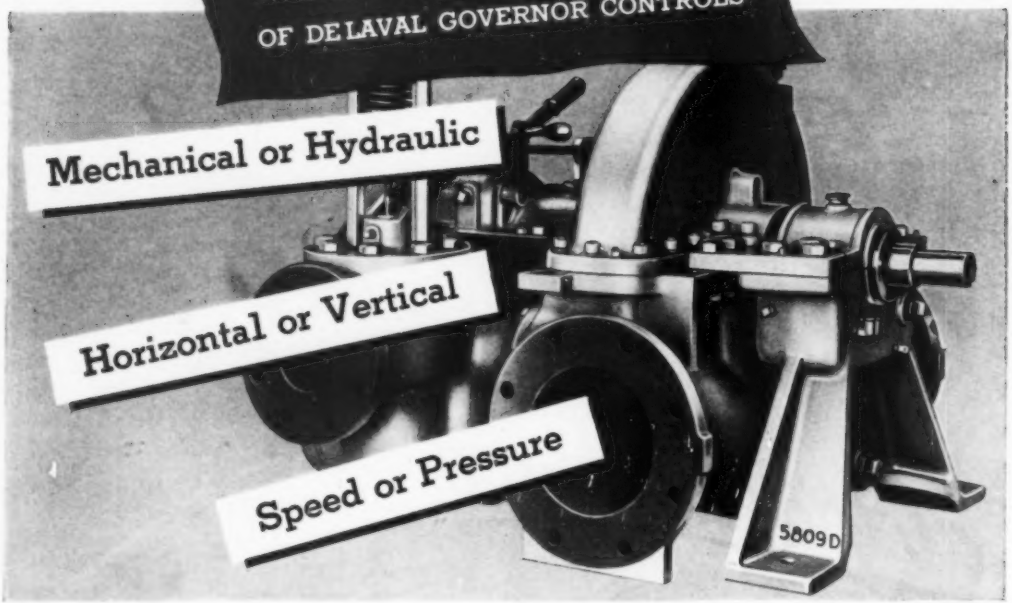

Whatever your control requirements, De Laval Class CA Turbines can be equipped with a governor that will meet the demand. The following types are available:

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4. *Hydraulic oil relay* for close regulation or for supplying extra power for valve movement.
5. *Flyweight oil relay* for close regulation such as encountered in synchronous generator drives.
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Combinations of the above types can be supplied as required to meet specialized conditions.

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- ✔ True center line support and flexible mounting for perfect alignment.
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- ✔ *Positive* over-speed protection entirely separate from normal speed governor for unfailing emergency shut-off.
- ✔ Super-smooth, chrome plated shaft journals make carbon rings last longer.
- ✔ Casing and bearings split horizontally at center line for easy removal and inspection of the rotor, carbon rings and bearings.

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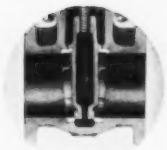
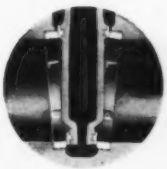


Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

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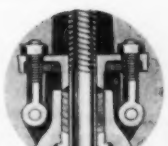
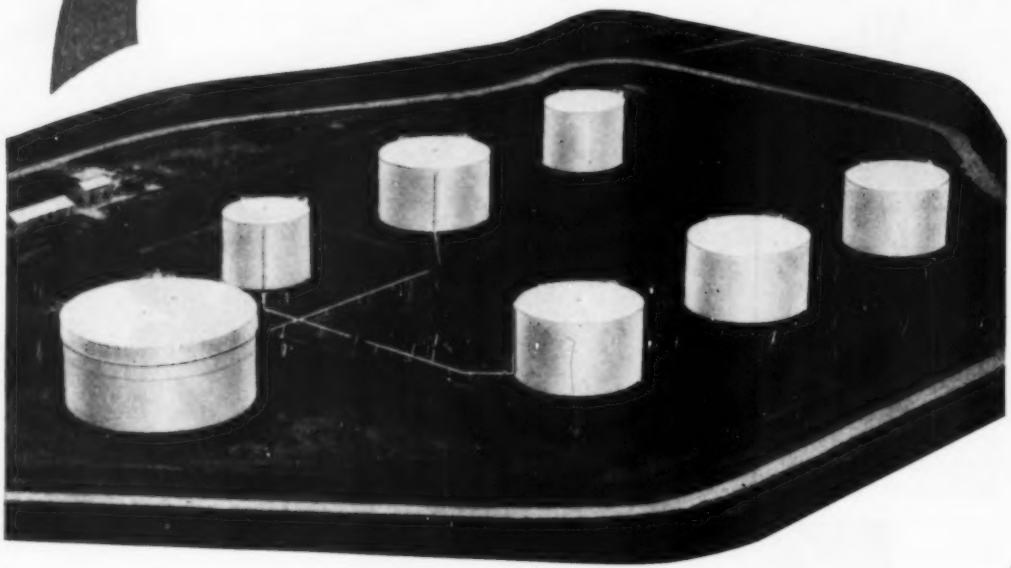


Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

7 POINTS IN FAVOR OF GRAVER EXPANSION ROOF TANKS



Make a point-by-point comparison and you will be convinced that the Graver Expansion Roof Tank is ahead on any score. For example:

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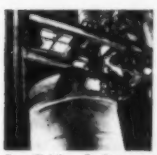

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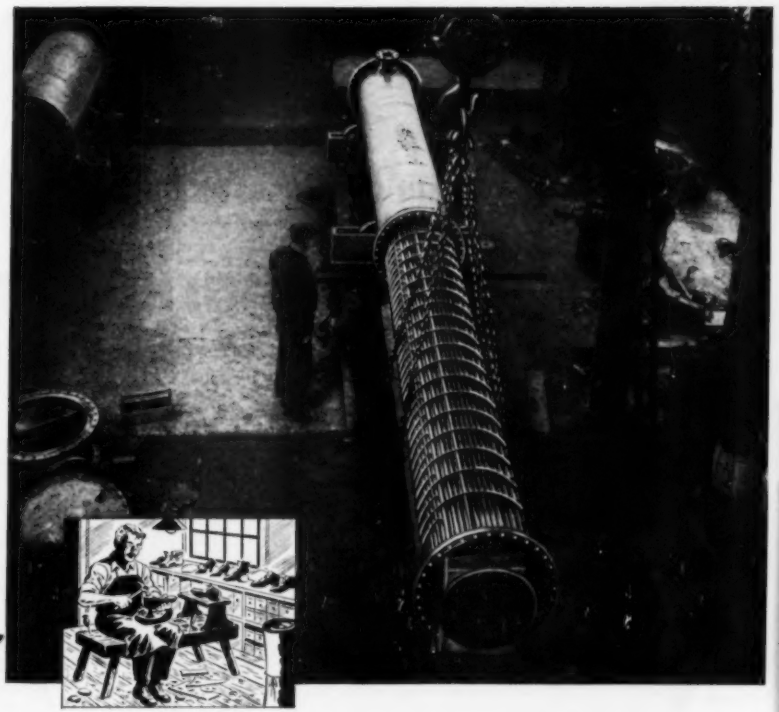

Will it be a good fit?

FABRICATING a heat exchanger shell might be compared to making a pair of shoes. You can make them relatively easily but will they fit when you put them on.

Of course one way you could assure getting your feet into them would be to make them a size too large. But they wouldn't be very comfortable. What you want is a pair of shoes that fits *perfectly!*

That's pretty much the story with exchanger shells. They must be fabricated to close tolerances if they are to serve their purpose efficiently. A shell that's made "a size too large" through lack of skill or mistaken economy doesn't make an effective heat exchanger, because the fluid that must pass in close contact with all the tubes in the bundle "escapes" around the outside due to the extra space. Baffles fail to divert it sufficiently to overcome this fault.

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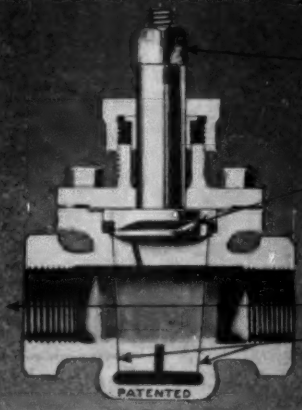

1. Quarter-Turn fully opens or closes.

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3. Straight-line fluid flow. Minimum pressure drop.

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HOMESTEAD Cam-Seald QUARTER-TURN VALVES

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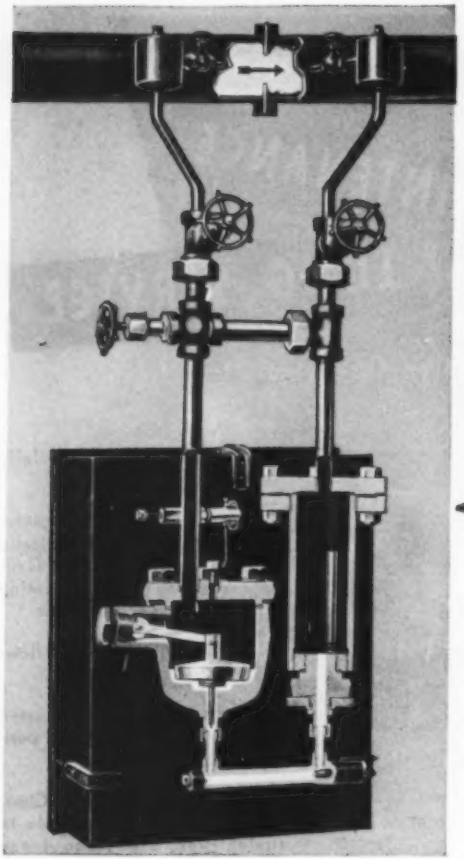

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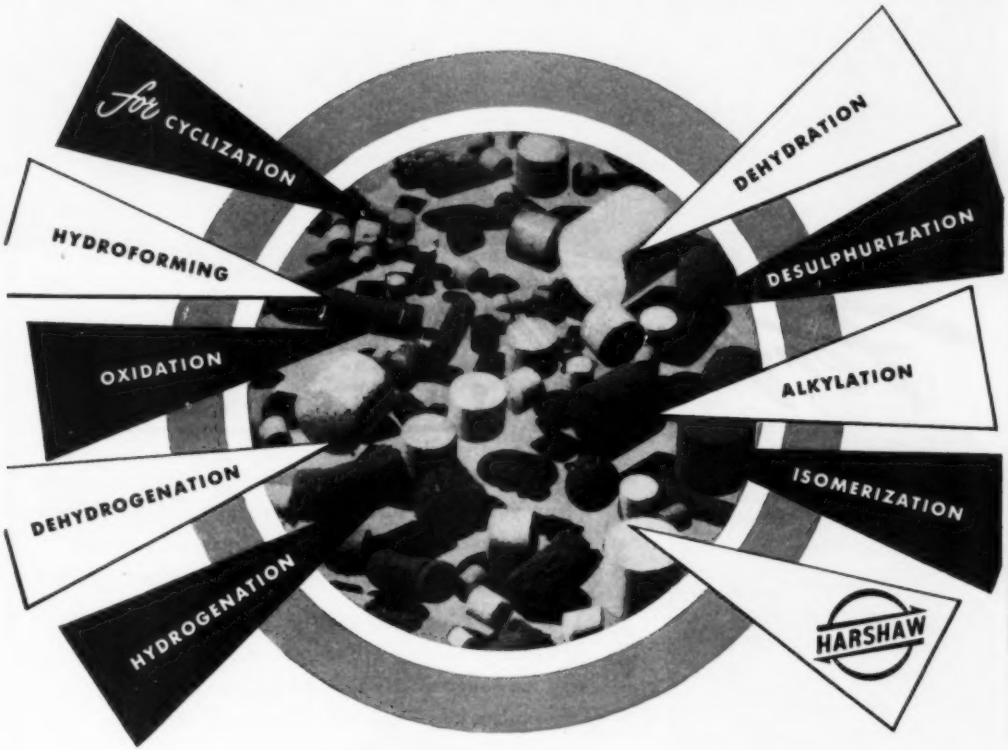

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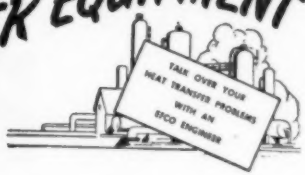
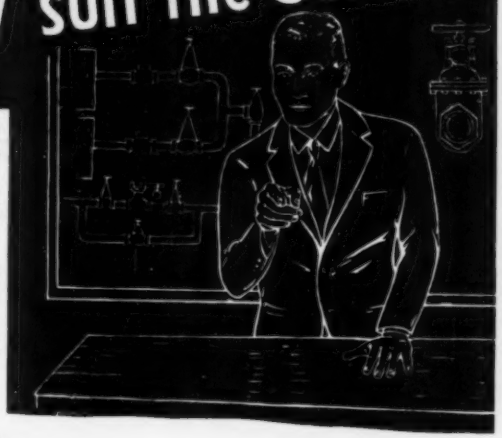


1st Lesson in Flow Control – the Valve *MUST* suit the Service



It's an established fact that there's more loss in time and money through misapplication of valves than from any other known cause.

Fortunately this can be avoided. All you need to do is standardize on the Powell Line of Valves*—because this is what you get—

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III Many Special Designs for Special Services.

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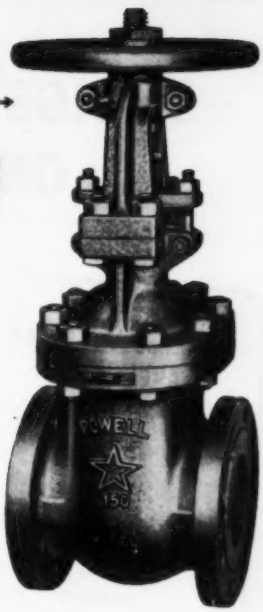
With such facilities at your disposal and Powell Engineers always ready to help you select the right valves, why take chances with your flow control equipment. Standardize on POWELL VALVES.

Fig. 1503—Class 150-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge. →



* Powell Valves are made in Bronze, Iron, Steel and a wide selection of Corrosion-Resistant metals and alloys. Valves of every type—Globe, Angle, Gate, Check, Non-return and Flush Bottom Tank Valves—are included in the Complete Powell Line.

Fig. 6061—Class 600-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through valve body.

Fig. 1708 — 200-pound Bronze Globe Valve with union bonnet, renewable specially heat treated stainless steel seat and regrindable, renewable wear-resisting "Powellium" nickel-bronze disc.

Fig. 375 — 200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 500 — 125-pound Bronze Gate Valve with screwed ends, screwed-in bonnet, inside screw rising stem and tapered wedge, solid or double.

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Engineering problems solved in the laboratory are problems no longer — yet in steel and alloy plate fabrication there are factors where the right answers yield more readily to common sense than to the slide rule.

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As a matter of fact, from the very first moment you begin to think about steel and alloy plate fabrication, it's common sense to think about the General American Plate & Welding Division.

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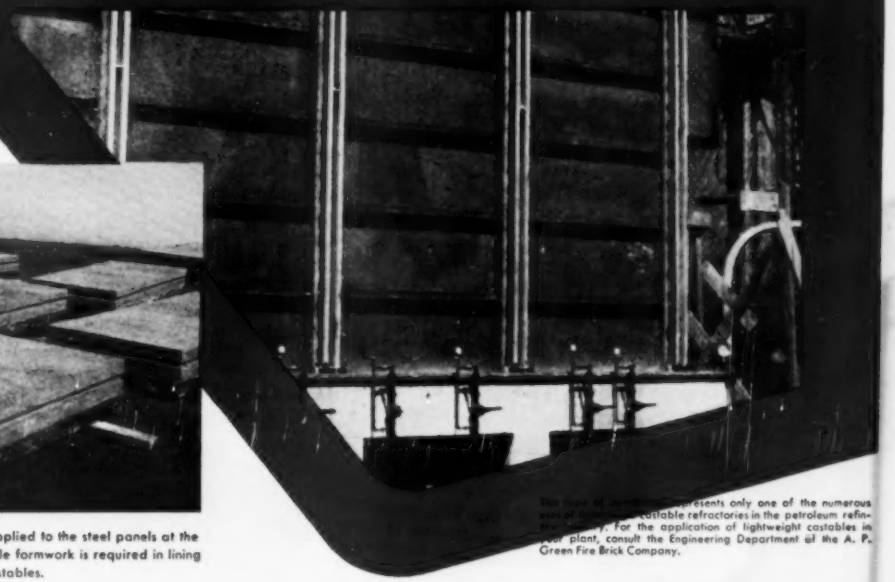
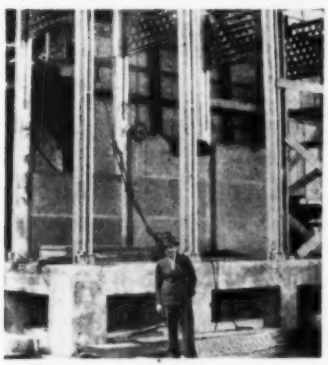


This view of [illegible] represents only one of the numerous [illegible] castable refractories in the petroleum refinery. For the application of lightweight castables in your plant, consult the Engineering Department of the A. P. Green Fire Brick Company.



Erection is simplified by installation of pre-fabricated panels.

A. P. Green Castable Refractories applied to Panel Casing Construction in new or old oil heaters and stills, offers you these 6 advantages:

1. Use of lightweight castable refractory materials developed for high operating temperatures.
2. Securely anchored lining—gives long, trouble-free service.
3. Increases the performance and efficiency of the furnace. With fewer joints air infiltration is reduced to a minimum.
4. Simplified construction—reduces erection time.
5. Lowers maintenance costs. Any tube section may be repaired by removing a series of the panels without disturbing the balance of the furnace arrangement.
6. Lower foundation costs due to the use of lightweight materials.

The A. P. Green Fire Brick Company Engineering Department will assist you with further information on the application of these materials to new units or the conversion of existing furnaces. Call your local A. P. Green distributor—he's listed in the yellow pages of your telephone directory—or write . . .

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY

Mexico, Missouri, U. S. A.

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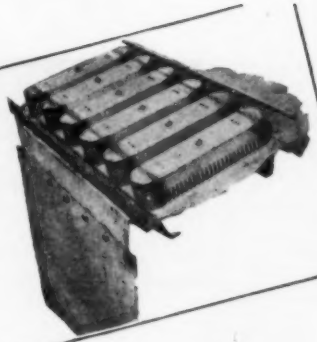
Distributors in the Principal Cities of the World

GLITSCH

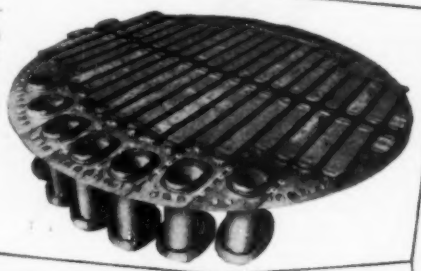
Bubble Trays
Bubble Caps
Rain Decks
Shower Decks
Accumulator Trays
Blank Trays

New Installations or Replacements

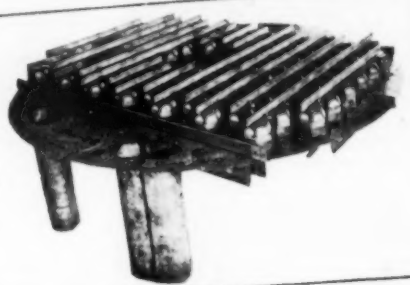
GLITSCH builds trays to fit. This one is only 28" for a 30" diam. tower. It is made of stainless steel, type 410, 12% chrome. Thickness is 12 and 14 gauge. Tray has blank end caps on the overflow side of the tray, with a notched overflow weir. Tray is entirely removable.



A 12% chrome alloy tray 12'-0" in diam. Decks and caps 14 gauge, supports 12 gauge. Seal pots on downcomers of tray. It is one of several replacing existing equipment in a unit having considerable corrosion of tower internals. Stainless alloy solved the tray corrosion problem.



A 9'-10" diam. tray for a 10'-0" I. D. tower. Material 12 gauge 12% chrome alloy. Note hexagon caps with hold-down bars running in direction of flow. Center manway is provided in tray for access to trays below.



GLITSCH Can Fabricate the Tray You Want!

By working with all suitable light-weight metals and alloys, trays can be designed to fit your refining problems, installed in the quickest time with the fewest men. Trained representatives from nearby offices will be happy to talk with you. No obligations whatever!

Glitsch

MANUFACTURED UNDER U. S. PATENT NO. RE 22946; NO. 2,341,091; NO. 2,309,309; NO. 2,338,928; NO. 2,375,409; NO. 2,420,075; NO. 2,422,300; NO. 2,461,729 AND OTHER PATENTS PENDING

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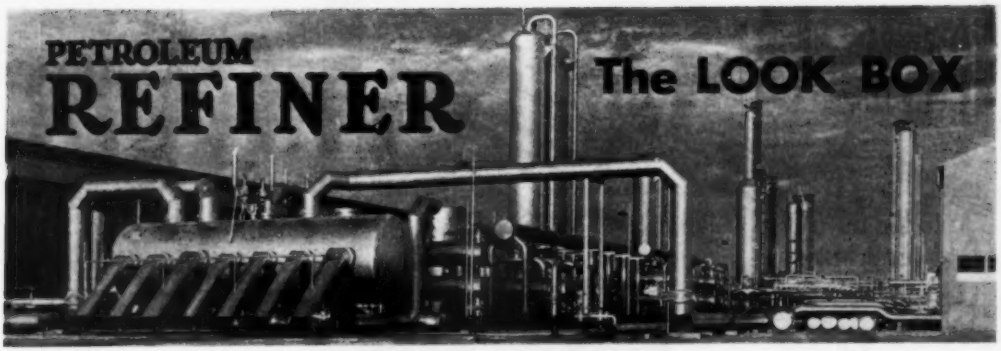


THE lowered demand for most refinery products, except gasoline, is leading many refiners to plan plant modification and process expansion programs as the most likely solution for marketing and profit problems.

New Process Units

A heavy demand for gasoline continues and promises to increase. Refinery thruputs are down in most areas this year, though, because of lessened consumption of residual fuel oils and the middle distillates. As a result, refiners generally are faced with serious problems. Without addition process facilities, increased gasoline production also increases fuel oil production. Many are hard pressed to find sufficient storage for fuel oils. Current high crude oil prices and lowered fuel oil returns cut sharply into plant profits. Competition from major company imports of foreign crude oils has been cited by some independents as contributing to their difficulties. For such various reasons, several of the smaller refineries have been shut down.

Because of these conditions, refiners troubled with fuel oil marketing problems are presently operating their plants for maximum gasoline yield and minimum fuel oil. High fuel prices in recent years have often resulted in plant operation at less than maximum percentage gasoline yield and some refiners accordingly had idle cracking or reforming capacity which has now been returned to service. Others are buying new process units. General Petroleum Corporation, foresighted in the construction of the world's largest delayed coking unit at their Torrance, Calif., refinery in 1946, has announced a plan to expand these facilities by 50 to 80 percent. Also recently, The Lummus Company and Gulf Research and Development Company has announced extensive pilot-plant-scale operations with a newly developed continuous coking proces. The several catalytic cracking processes are important factors, too, in increasing the yield of distillate products, and the various gas conversion processes contribute to the total yield of gasoline per barrel of crude oil refined.

When the predicted high demand for gasoline is weighed against the present market and prices for gasoline, fuel oil, and crude oil, there seems little doubt that refiners will undertake the fairly extensive construction projects that many of them will need to materially increase their percentage of gasoline yield.

WHAT kind of business-management job needs be done by industry in order to demonstrate the "lasting value of free enterprise to the satisfaction of those who collectively are American?"

Importance of Industry Planning

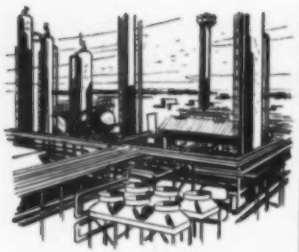
That's the question asked recently by David F. Austin, vice president of United States Steel Corporation of Delaware. Planning that is flexible, realistic organized and continuous—this was his answer:

"I am concerned over the subversive fronts in this country, but I am more disturbed by the fact that an alarming number of people of the United States are unknowingly turning away from the ideals of free enterprise and are moving unwittingly in the direction of a welfare state. This group seems anxious to turn to the government as a panacea of every ill. I heartly share the desires of any group that desires to eliminate the extremes of boom and bust which have attended our economic progress; but I deplore the willingness of any group to let the government do their thinking for them.

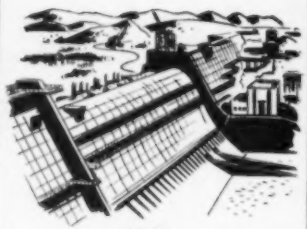
"We must attempt to develop a sounder working relationship with government on the one hand and with labor on the other; we must foster a spirit of team work in the best interest of the nation as a whole.

"Second, re-establish the rule of reason in the climate in which business operates. Self-regulation in the public interest is an essential step toward solving this problem. We must demonstrate that size in business, far from being a blight upon the economic structure, will continue, as in the past, to endow this country with the benefits of greater productivity, lower prices, and wider distribution.

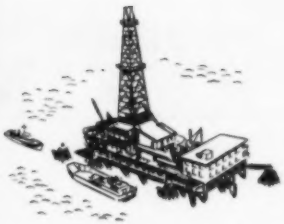
"Furthermore, we must be permitted to compete for a share of any consumer's business, anytime,



GASOLINE PLANTS



DAMS

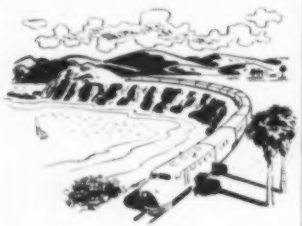


OFFSHORE PLATFORMS

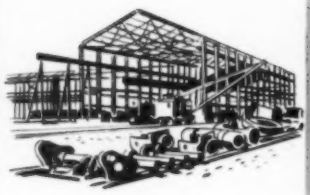
BRIDGES

YOUR PROBLEM IS OUR PLEASURE

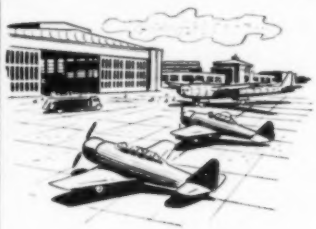
HIGHWAYS



RAILROADS



CHEMICAL PLANTS



MILITARY INSTALLATIONS

Brown & Root, Inc., prides itself on an organization that has met and vanquished the problems surrounding nearly every type of heavy construction. Experience is a stern but thorough teacher, and discoveries made on one project save other clients much time and many dollars.

As long as there is progress there will be new problems, but most of them will be first cousins to the old ones we learned about the hard way.

Tell us your troubles. We may have the solution already worked out.

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anywhere. Taxation must remain a source of revenue used to provide required government services, not a punitive measure used to discourage enterprise or to destroy initiative; and finally, we must continue to assist, as in the case of the Hoover commission, to improve the efficiency of our government.

"To utilize our present industrial facilities properly and to clear the way for further sound expansion, we must continue to strive for wider and wider distribution of all products, we must have more effective selling. Planning for the future, means that industry must staff and organize our companies to handle more than just the immediate problems of production and sales.

"The first and cardinal principle of sound organization planning is the recognition and anticipation of change—and we must cultivate the ability to adjust ourselves to meet this challenge.

"The second principle is realism—the kind of realism which only broad business experience provides. The need for realism is illustrated in some of the criticism which has recently been leveled at the steel industry regarding capacity.

Third, any planning and forecasting which we attempt must be on an organized basis. Fourth, and in part a conclusion: prudent planing is a continuing process. Planning for the future is a difficult and risky occupation. However, each of us, no matter what our position, is constantly forced to make certain predictions and act on them. The job of looking to the future and of formulating plans and programs is a continuing one, not only to keep abreast of changing conditions, but also, as each year goes by, to develop an ever clearer and more exact picture of what lies ahead."

Problem of Liquid Fuels

THE first continuous shale oil refinery in this country, the Bureau of Mines' 200-barrel-per-day experimental unit near Rifle, Colorado, has been "put-on-stream."

This experimental plant includes a highly flexible refining unit designed to separate the gasoline, diesel fuels, heating fuels, and fuel gases of crude shale oils extracted at the site. The complete installation includes facilities for mining the shale, retorting to yield crude shale oil, and apparatus for refining or converting the crude shale oil into useful products.

Economics will finally control the possible construction of commercial plants of this type, of course, and current informed opinion as to their feasibility varies widely. Perhaps the most significant feature of this first plant, from the viewpoint of petroleum industry refinery technical men, designers, and equipment manufacturers, is the marked similarity between the refining portions of this shale oil plant and conventional oil refinery practice. Major pieces of equipment include a furnace, cooking chambers, fractionator, diesel cut stripper, naphtha stabilizer, gas absorber, and a column for rerunning acid-treated gasoline.

Present experimental work is directed to the collection of data on atmospheric distillation, delayed coking, single coil recycle cracking, and naphtha reforming, with crude shale oil or its fractions as the charge stocks.

In both design and function this fractionation section of the plant is conventional. This should provide assurance, if any is still needed, to that part of our industrial system concerned with the processing of petroleum and with the manufacture of process equipment, of a continuing and increasing market for their abilities and facilities in the manufacture of liquid fuels.

Not long back a great flurry of talk, coupled with predictions of disaster that hinged on the eventual exhaustion of our petroleum resources, caused widespread alarm within our industry, in government circles, and with the general public. The basic causes for this alarm are real enough and present problems which must be met. The popular alarm, now subsided, was undoubtedly much influenced by some temporary difficulties in product distribution long since worked out.

During the excitement some rather rash proposals were made then to assure continuing supplies of liquid fuels. Present economics seem to indicate the development of gasoline synthesis from coal as an eventual principal solution, with natural gas gasoline synthesis and shale oil refining as intermediate and perhaps marginal steps influenced by economic pressures and perhaps by military needs.

Whatever the route followed to make liquid fuels, though, future plants in their essential elements will be similar to present day refineries and gasoline plants. There will be some additional equipment for mining shale, or coal, or for gassifying coal in place, some crushing equipment, retorting apparatus, extraction equipment, and soon for raw oil recovery. The balance of the plants will be closely related to present refineries—or at any rate will be the future versions of process equipment developed from our present practice. Since the oil demand is expected to rise and process complexity increase, it seems certain that expenditures for plant construction, operation, and maintenance will also increase.

U. S. Refining

Operations Down

U. S. REFINERY operations have been curtailed this year because of the lagging demand for most of the refined products except gasoline and because of the efforts to avoid accumulation of excessive stocks. On a daily average basis, total crude runs to stills were 2.5 percent lower in the first half of 1949 than in the first six months of 1948, having been off to 5,353,000 barrels daily from 5,493,000, a decrease of 140,000 barrels daily.

Refinery runs of domestic crude averaged 4,951,000 barrels daily in this year's first half, a decrease of 249,000 barrels from the 5,200,000 per day processed in the initial half of 1948. Runs of foreign crude were increased to 402,000 barrels per day from 293,000 daily last year, a gain of 109,000 daily or 37.2 percent.

The total volume of all crude run to stills in this year's first half was 968,935,000 barrels, a decrease of 30,737,000 barrels or 3.1 percent from the 999,672,000 barrels processed in the first six months of 1948, which had the extra day for Leap Year. Total amount of domestic crude charged to stills in the first half of 1949 was 892,213,000 barrels, a decrease of 50,080,000 barrels or 5.3 percent from the 946,293,000 barrels run in last year's first half.

The different refining districts have shown widely varying trends in refinery operations. Runs have been sharply lower this year than last year on the East Coast, the Texas Gulf Coast, and in inland Texas. They have been moderately lower in other districts except California and the Middle West, where increases are shown.

On the East Coast, total runs of 137,968,000 barrels in this year's first half were off 18,043,000 barrels or 11.6 percent from those of 156,011,000 barrels in last year's first six months. On the Texas Gulf Coast, runs totaled 234,962,000 barrels, a decrease of 14,085,000 barrels or 5.7 percent, from the 249,047,000 in the like period last year. For inland Texas runs of 39,639,000 barrels were 5,381,000 barrels or 12 percent less than the 45,020,000 barrels last year. In the Appalachian district, runs totaled 28,755,000 barrels compared with 30,583,000, a decrease of 6 percent.

Mid-Continent Figure

In Oklahoma, Kansas, and Missouri, runs for the six months this year totaled 76,153,000 barrels, 5.6 percent less than the 80,691,000 last year. On the Louisiana Gulf Coast, runs totaled 76,749,000 barrels, off 1.1 percent from 77,614,000. In North Louisiana and Arkansas, runs amounted to 13,354,000 barrels or 7.2 percent less than the 14,389,000 of last year.

In California, total runs amounted to 167,007,000 barrels, an increase of 8,373,000 barrels or 5.3 percent from the 158,634,000 barrels for the first half of 1948. In the Rocky Mountain district, runs totaled 30,906,000 barrels, an increase of 1,965,000 barrels or 6.8 percent from the 28,941,000 barrels last year.

In June of 1949, U. S. crude runs to stills averaged 5,236,000 barrels daily, a decrease of 7 percent from the 5,632,000 daily recorded for June of 1948, when the industry was still in the period of all-out operations to avoid threatened shortages.

While runs have been curtailed, refinery capacity in the U. S. has been increased materially since a year ago. Consequently, plants have been operating at considerably lower percentages of capacity than at mid-year of 1948. Total capacity of U. S. plants in June of 1949 was placed at 6,340,000 barrels of crude daily, an increase of 502,000 barrels over that of 5,838,000 daily for June of last year. The actual runs of June 1949 represented utilization of 82.6 percent of U. S. capacity, whereas runs of June 1948 had been 96.5 percent of capacity.

Stiffer Competition Seen for Oil

IMPROVED coal-burning equipment and a huge expansion program in the distribution of natural gas will offer the petroleum industry stiff competition in the heavy oils and middle distillate range. A few years ago such competition from solid fuels was considered a thing of the past. The home-heating market was inconsequential, and the oil industry's chief business was gasoline. Other products produced in the process of refining gasoline were sold at the best price they could bring.

But with the development of the light burning oil market, a wholly new turn

U. S. Crude Runs to Stills and Percent of Refinery Capacity Used, by Districts, June and First 6 Months 1948, 1949

Runs from Bureau of Mines, except May and June, 1949, from American Petroleum Institute. Capacities from American Petroleum Institute

(THOUSANDS OF BARRELS)

REFINING DISTRICT	CRUDE RUNS IN JUNE: Total Amount Run			CRUDE RUNS IN JUNE: Daily Average Run		REFINING CAPACITY IN USE, JUNE: Daily Capacity		REFINING CAPACITY IN USE, JUNE: Percent Capacity Used		TOTAL AMOUNT OF CRUDE RUN TO STILLS FIRST 6 MONTHS		
	June, 1948	June, 1949	% Dif. '48-'49	June, 1948	June, 1949	June, 1948	June, 1949	June, 1948	June, 1949	Jan.-June, 1948	Jan.-June, 1949	% Dif. '48-'49
East Coast	26,936	21,179	— 21.4	898	706	830	891	108.2	79.2	156,011	137,968	— 11.6
Appalachian	4,870	4,531	— 7.0	162	151	191	193	84.8	78.2	30,583	28,755	— 6.0
District No. 1	3,106	2,844	— 8.4	103	95	123	118	83.7	80.5	18,288	16,969	— 7.2
District No. 2	1,764	1,687	— 4.4	59	56	68	75	86.8	74.7	12,295	11,786	— 4.1
Indiana, Illinois, Kentucky	26,832	26,078	— 2.8	894	869	980	1,080	91.2	80.5	158,742	163,442	+ 3.0
Oklahoma, Kansas, Missouri	14,064	12,803	— 9.0	469	427	474	500	98.9	85.4	80,691	76,153	— 5.6
Texas Inland	7,439	6,201	— 16.6	248	207	297	296	83.5	69.9	45,020	39,639	— 12.0
Texas Gulf Coast	42,165	37,727	— 10.5	1,406	1,257	1,349	1,559	104.2	80.6	249,047	234,962	— 5.7
Louisiana Gulf Coast	12,535	12,004	— 6.5	428	400	365	458	117.3	87.3	77,614	76,749	— 1.1
North Louisiana and Arkansas	2,501	2,274	— 9.1	83	76	121	96	68.6	79.2	14,389	13,354	— 7.2
Rocky Mountain	4,981	5,556	+ 11.5	166	185	190	213	87.4	86.9	28,941	30,906	+ 6.8
District No. 3	361	330	— 8.6	12	11	15	15	80.0	73.3	2,171	2,084	— 4.0
District No. 4	4,620	5,226	+ 13.1	154	174	175	198	88.0	87.9	26,770	28,822	+ 7.7
California	26,329	28,738	+ 9.1	878	958	1,041	1,054	84.3	90.9	158,634	167,007	+ 5.3
Total United States	168,952	157,091	— 7.0	5,632	5,236	5,838	6,340	96.5	82.6	999,672	968,935	— 3.1

was given the economics of petroleum marketing. Dr. Courtney Brown, head of the economics department of Standard Oil Company (New Jersey), points out that this market was developed beyond the by-product status when it was recognized as a means to iron out peaks that occurred in the oil market in the summer and troughs that occurred in winter. By 1934 winter demands for all oils were about as high as previous summer demands. By 1948 winter demands were 700,000 barrels a day more on the average than the previous summer demands.

From 1932 to 1948 petroleum consumption in the U. S. increased at a rate of about 6 percent compound annually over that 17-year period. During those same years demand growth for heating oils was even more spectacular. A requirement of only 269,000 barrels a day in 1932 was pushed to 1,235,000 barrels a day by 1948, a compound rate of annual increase of 10 percent. Gasoline, on the other hand, showed a compound consumption increase of only 5.4 percent.

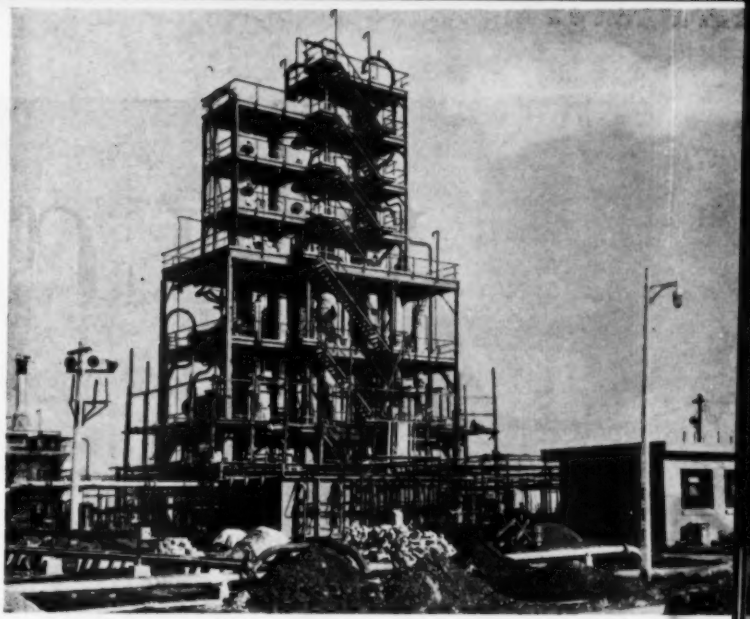
In 1932 light heating oil demand was only 12 percent of all domestic crude and product demand. By 1948 this figure had risen to 21½ percent of total. Light burning oils made an increase of 14.4 percent of total demand in the years from 1932 to 1941, but in the three post-war years 1946 through 1948 they had risen to 20 percent of total demand. Gasoline dropped from a pre-war average of 44.7 percent of total demand to a post-war average of 40.7 percent.

Petroleum's Economic Health

These figures show that the economic health of the petroleum industry is becoming increasingly bound up with the economics of the middle distillate range of products.

And strange to say, that is just where coal is taking on a new competitive significance. This due to the fact that the middle distillate range of oil products is the most influenced by competitive prices. A change in the price of light heating oils readily influences demand. A space heater which the consumer can buy for a $100 and install himself will consume 14 to 16 barrels of fuel a year, or almost as much fuel as is consumed by an automobile costing $3000 to $4000. In 1947 it was cheaper on a straight heat content basis to burn convenient liquid fuel to heat homes than it was to use solid fuels, and oil burner installations were at record levels, resulting in scarcity of heating oil and higher fuel oil prices. The scarcity and higher prices of oils then reacted against oil burner installations and heating oil demand in 1948 and worked to the advantage of coal. In 1949 prices of fuel oils have declined rather drastically, with these oils in oversupply, and oil burner installations have been materially accelerated.

Meanwhile, the coal industry is seeking to cut costs of coal mining through improved machinery, and is promoting development and use of improved coal-burning equipment, endeavoring to make coal attractive in price and convenient to use. The coal industry is pushing a "heat your home by coal" program, and has developed a series of coal-burning appliances that are far more efficient and clean than any ever before known. Now in this third year, the Coal Heating Service has an organization of 54 local retailer setups at the community level, involving about 1500 retail coal merchants. This is a cooperative merchandizing and promotion campaign by which coal producers, through the National Coal Association, match funds and give professional advice and service to groups operating at the community level.



AUSTRALIA PLANT OPENS—Process operations have started in the 1200-barrel-a-day Altona refinery near Melbourne, Australia, Standard-Vacuum Oil Company announced last month. The refinery is owned by a subsidiary, Vacuum Oil Company, Pty., Ltd.

The new plant will process more than 400,000 barrels of crudes a year into nearly 5 million gallons of industrial lubricating oils which now have to be imported by Australia. In addition, Vacuum will produce here 129,000 barrels of diesel oil a year, 113,000 barrels of asphalt and a small quantity of gasoline. Establishment of the refinery will contribute a material saving in Australian dollar exchange, officials pointed out.

Located on a 200-acre site six miles from Melbourne on Port Phillip Bay, Vacuum's Altona refinery cost $3 million. Tanker unloading facilites located on the Yarra River three miles away are connected to the refinery by pipe line.

Crude will be received initially from the Tia Juana field in Venezuela and later from the Klamono field in western New Guinea. No commercial production of crude has yet been obtained in Australia.

The new home coal-burning unit is a smokeless stove, clean in operation and inexpensive in fuel use. One typical device, perfected by the Bituminous Coal Research Institute, uses all kinds of bituminous coal, creates no smoke and leaves no clinkers. The time between refueling is 12 to 24 hours for normal winter operation.

In the industrial field, coal considerably bettered its competitive position with oil during 1947 and 1948. When residual fuel oil prices were climbing toward their peak in 1948, many industrial plants went back to their coal standby facilities. Since the beginning of 1949, supply of residual has exceeded demand and prices have come down sharply putting oil back into strong competition with coal.

The significant fact in the current coal utilization program is that for the first time coal is threatening to take away markets that previously were captured from it by oil. Not only is that true of the home-heating field and industrial plants, but also it is claimed that railroad dieselization will be slowed because of the newly developed coal-burning locomotive. This engine is a gas turbo-electric unit which uses pulverized coal to develop its 4500 horsepower.

However, not coal but natural gas is the relatively new competitor that may change the whole economics of the petroleum industry again. Gas now provides a seventh of all energy produced in the U. S. From a mere regional fuel it is rapidly becoming national in character. Consumption has risen from 339 billion cubic feet in 1906 to 4.4 trillion cubic feet in 1947, a volume carried through a nationwide system of 243,000 miles of pipe lines. Standard Oil Company officials predict that by 1952 a network of 261,300 miles of pipe line will transport and deliver 9 trillion cubic feet a year of natural gas.

Only gradually will natural gas come into direct competition with oil at the home level. Much of the increase volume to be distributed will go as enrichment for manufactured gas in place of fuel oil. Meanwhile, oil burner sales for household use are expected to climb.

Yet there has always been a consumer tendency to convert burners to natural gas as rapidly as gas became available. Standard Oil Company (N. J.) officials say the reason for this is "basically, because gas is the cheapest of the three principal fuels in most places where it is available, and because it is by far the most convenient." Natural gas on the average costs only a little more than one-third the price of manufactured gas and yields twice as much heat. And, according to the Bureau of Mines, domestic users account for 24.6 percent of all the natural gas now being used.

Engineers and Manufacturers
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PRE-FABRICATED PROCESS PIPING, SOLVENT EXTRACTORS, VEGETABLE OIL EXTRACTORS**

VULCAN *has served the process industries since 1901. Below is a representative list of chemicals processed in Vulcan plants or equipment.*

ALCOHOLS Methanol — synthetic
Methanol — from wood distillation
Ethanol — industrial grades from molasses and grain
Ethanol — from sulfite waste liquor
Ethanol — anhydrous, Vulcan process
Ethyl alcohol — beverage, neutral spirits
Isopropanol Allyl alcohol Butanol

ALDEHYDES
Acetaldehyde Butyraldehyde Furfural

CHLORINATED HYDROCARBONS Chloroethane Chlorobenzenes Chlorotoluenes

ACIDS Formic acid
Acetic acid — from wood distillation
Acetic acid — from process residues and solvent recovery
Acetic anhydride Propionic acid
Butyric acid Stearic acid

GLYCOLS Ethylene glycol
Butylene glycol

KETONES
Acetone Methyl ethyl ketone

ESTERS Methyl acetate Ethyl acetate
Butyl acetate Vinyl acetate Dibutyl phthalate

HYDROCARBONS Butadiene Heptane
Benzene Toluene Styrene Diphenyl

PHENOLS Phenol Naphthol

ETHERS Ethyl ether Isopropyl ether

MISCELLANEOUS Citronellal Geraniol

DDT Essential oils

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REFINERY and Other PLANT CONSTRUCTION

(Also See Other Construction News, Page 171)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
E. I. DuPont	Parkersburg, W. Va.	Tetrafluoroethylene Resin Plant			Under Constr.	Summer, 1950			
Esso Standard Oil Co.	Linden, N.J.	Vac. pipe still	49,000 bbls.		Under Constr.	2nd Qtr., 1949		S.O.D. & Braun	Braun
Esso Standard Oil	Linden, N.J.	Cat. Crack, Light Ends	41,000 bbls.		Under Constr.	3rd Qtr., 1949		S.O.D. & Braun	Braun
Esso Standard Oil	Bayonne, N.J.	Dewaxing	7,500 bbls.		Under Constr.	1st Qtr., 1950	Texaco	Badger	Badger
Esso Standard Oil	Linden, N.J.	Steam Boiler	260,000 lbs. hr.		Under Constr.	2nd Qtr., 1949		S.O.D.	
Esso Standard Oil	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr.		Under Constr.	2nd Qtr., 1950		S.O.D., Day & Zimmermann	S.O.D. & Zimmermann
Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery Plant	40 tons		Contracted				Girdler
Gulf Oil Corp.	Philadelphia, Pa.	Topping and Vacuum Unit	30,000 bbls.		Under Constr.	Nov., 1949		Lummus, Badger	Lummus
Pure Oil Co.	Savannah, Ga.	Lube Blending & Packaging Plant			Under Constr.	Nov. 1, 1949			
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Crude, Dist. Unit	19,500 bbls.		Under Constr.	Fall, 1949		Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Propane Deasphalting	5,950 bbls.		Under Constr.	Late 1949	Juik	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	2,050 bbls.		Under Constr.	Fall 1949	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Light Oil Treating Plant	28,000 bbls.		Designing	Dec., 1949		Badger	Badger
L. Sonneborn Sons, Inc.	Petrolia, Pa.	Enlarge Anti-Pollution		$400,000	Under Constr.	Mid 1949		Chemical Constr. Co.	Morris Knowles & Co.
Sun Oil Co.	Marcus Hook, Pa.	Wax			Under Constr.	July, 1949	Texaco	Staff	Staff
Sun Oil Co.	Marcus Hook, Pa.	Comp. & Pkg.			Under Constr.	Nov., 1949		Staff, Lindsay	W. W. Lindsay
The Texas Co.	Beacon, N.Y.	Expand Research Labs.			Under Constr.	Dec. 1, 1949		Voorhees, Walker, Foley & Smith	
The Texas Co.	Westville, N.J.	New Refinery	40,000 bbls.		Under Constr.	Indefinite		Foster-Wheeler, Jackson-Moreland, Kellogg	Foster-Wheeler, Kellogg
U.S. Dept. of Interior	Bruceton, Pa.	Fischer-Tropsch Pilot Plant (Coal-to-gasoline synthesis)	1-2 bbls.	$250,000	Under Constr.	Nov., 1949		Staff	Blaw-Knox Co.
MID-CONTINENT									
Ashland Oil & Refining Co.	Canton, Ohio	Ref. Modernization			Under Constr.	Middle 1949			Cat. Constr.
The Carter Oil Co.	McKamie, Ark.	Pressure Maintenance Unit Expansion	38,000 mcf		Under Constr.	July, 1949		J. & L. Constr.	J. & L. Constr.
Champlin Refining Co.	Enid, Okla.	Crude Unit	18,000 bbls.	$600,000	Under Constr.	Fall, 1949		Koch	Staff
Champlin Refining Co.	Enid, Okla.	Cat Poly Unit	450 bbls.	$200,000	Under Constr.	Fall, 1949	U.O.P.	Koch	Staff
Cities Service Oil Co.	Chicago, Ill.	Compounding & Grease Plant	1,200 bbls.	$4 million	Under Constr.	Late 1949		Sumner-Sollitt	Sumner-Sollitt
*Cities Service, Del.	Cicero, Ill.	New Compound Plant		$4 million	Contracted	July, 1950			Summer S. Sollitt & Co.
Cooperative Refinery Association	Coffeyville, Kansas	Dewaxing	2,200 bbls.	$1.5 million	Contracted	3rd Qtr., 1949	Texaco	Process Eng.	Process Eng.
Continental Oil Co.	Ponca City, Oklahoma	Crude Dist. Unit.	30,000 bbls.		Under Constr.	Oct., 1949		Bechtel	Bechtel
Deep Rock Oil Corp.	Cushing, Okla.	Cat. Cracker Plant	5,000 bbls.		Under Constr.	Spring 1950		J. & L. Constr.	J. & L. Constr.
*Deep Rock Oil	Cushing, Okla.	Fluid Crack Unit Gas Recovery Plant and Poly Plant							
Dewese Oil Co.	Weston, Ohio	Lube Filtering Unit	250 bbls.	$15,000	Under Constr.	Summer 1949		Staff	Staff
The Globe Oil & Refining Co.	Lemont, Ill.	Cat. Cracker Unit	6,000 bbls.	$1 million	Buying Material	Jan. 1, 1950	U.O.P.	U.O.P.	
Gulf Oil Corp.	Kiefer, Okla.	Expand Gasoline Plant	14,500 mcf		Under Constr.				
Gulf Refg. Co.	Toledo, Ohio	Fluid Cat. Crk.	15,500 bbls.		Under Constr.	Aug., 1949		Kellogg	Kellogg
Gulf Refg. Co.	Toledo, Ohio	Poly Unit	5,000 bbls.		Under Constr.	Aug., 1949	U.O.P.	Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Fluid Cat. Cracker Unit	15,500 bbls.		Under Constr.	Sept., 1949		Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Poly Unit	5,000 bbls.		Under Constr.	Aug., 1949	U.O.P	Kellogg	Kellogg
*Hoosier Gas Corp.	Vincennes, Ind.	Desulfo Unit	3,000 mcf/d.			Sept., 1949		Stacey, Dresser Eng. Co.	
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Cracking Unit	4,000 bbls.		Design			U.O.P.	Staff
Lion Oil Co.	El Dorado, Ark.	Ammonium Nitrate Prilling Plant	400 tons	$1,800,000	Under Constr.	Aug., 1949	Canadian Gov't.	Chem. Constr.	Blaw-Knox
Lion Oil Co.	El Dorado, Ark.	Sulfuric Acid Plant	300 tons	$1½ million	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr.
Lion Oil Co.	El Dorado, Ark.	Ammonium Sulfate Plant	180 tons	$750,000	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr., Blaw-Knox
M. F. A. Oil Co.	Chanute, Kans.	Desulfurization	1,000 bbls.	$75,000	Under Constr.	Sept., 1949	Phillips	Koch	Staff
Magnolia Pet. Co.	Grant County, Kans.,(Hickok)	Gasoline Plant	100,000 mcf		Under Constr.	Nov., 1949		Staff, Waleo	Waleo
Magnolia Pet. Co.	Chelwood, Okla.	Pressure Maintenance & Cycling	35,730 mcf		Under Constr.	Dec., 1949		Staff, Delta	Constr. Service
Magnolia Pet. Co.	Stephens County, Okla.	Gasoline Plant	30,000 mcf		Under Constr.	March, 1950		Staff, J. & L. Constr.	J. & L. Constr.
Midland Cooperative Wholesale	Cushing, Okla.	Cat. Poly Unit	200 bbls.		Authorized	Early 1950			Ref. Eng./U.O.P.
Northern Natural Gas Co.	Clifton, Kans.	Compressor Add.	1,000 hp.		Under Constr.	1949			Fluor
Ohio Oil Co.	Robinson, Ill.	Vac. Unit Cat. Crack. Crude Still, Poly, LP G Recovery	27,500 bbls.	$15 million	Under Constr.	Mid 1950	U.O.P.	McKee	McKee, Pritchard
Oklahoma Refining Co.	3 Mi. S.E. Seminole, Okla.	Refinery	200 bbls.	$40,000		Oct. 1, 1949			
Peteo Corp.	Blue Island, Ill.	Houdriflow Cat. Cracker Unit, LPG Recovery	5,000 bbls.	$400,000	Under Constr.	Last Quarter, 1949	Houdry	Houdry	Clarke

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REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Phillips Pet. Co.	Kans City, Kans.	Cat. Crack Cat. Poly	24,000 bbls. 1,500 bbls.	$10 million	Under Constr.	Nov., 1949		Braun	Braun
The Pure Oil Co.	Toledo, Ohio	Revamping Crude Reforming Units			Under Constr.	1st Qtr., 1949			Cat. Constr.
Rock Island Refg. Corp.	Rock Island, Ind.	Fluid Cat. Crk.	10,000 bbls.	$1,200,000	Under Constr.	July, 1949	U.O.P.	U.O.P.	Staff
The Shallow Water Refining Co.	Shallow Water, Kansas	Reforming Unit	1,250 bbls.	$85,000	Under Constr.	Fall, 1949	Pereo	Koch Eng.	Koch Eng.
Skelly Oil Co.	Eldorado, Kans.	Crude Dist. Unit, Cat. Crk.	35,000 bbls.	$8-10 million	Under Constr.	Mid 1950			
Socony-Vacuum Oil Co.	E. St. Louis, Ill.	Crude Distillation Unit	15,000 bbls.		Under Constr.	Aug., 1949		Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Thermal Cracking, Reforming, Vinbreaker Unit	13,200 bbls.		Under Constr.	Dec., 1949		Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Misel. Refinery Additions			Under Constr.	Sept., 1949		Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Delayed Coking Unit	8,000 bbls.		Under Constr.	Mar., 1950		Staff	Bechtel
*Socony-Vacuum	Augusta, Kans.	Houdry Conversion to T.C.C.	15,000 bbls.		Planned	Mid., 1950	Socony-Vacuum		
*Socony-Vacuum	Trenton, Mich.	Houdry Conversion to T.C.C.	15,000 bbls.		Planned	Mid., 1950	Socony-Vacuum		
*Standard Oil Co., (Indiana)	Whiting, Ind.	O.S.B.L. Facilities			Under Constr.	1949		Fluor	Fluor
Standard Oil Co. (Ohio)	Lima, Ohio	Furfural Refining Plant	76,000 gals.	$13 million	Contracted	1951	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Cat. Cracking	16,000 bbls.	$11 million	Under Constr.	Late 1949	U.O.P.	McKee	McKee
Standard (Ohio)	Lima, Ohio	Crude Distl. Coke	†15,000 bbls.	$5 million	Authorized	Mid 1950	Kellogg	Kellogg	Kellogg
Standard (Ohio)	Lima, Ohio	Solvent Dewaxing Unit	1,800 bbls. Finished Products		Authorized	Mid 1951	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.		Authorized	Mid 1950			Lummus
Standard (Ohio)	Lima, Ohio	Propane Desasphalting Unit	800 bbls.		Authorized	Mid 1950			Lummus
Sun Oil Co.	Toledo, Ohio	Cat. Crack, Crude Dist., Vac., Poly	30,000 bbls.	$16 million	Under Constr.	Jan., 1950	Houdry	Houdry, Cat. Constr., Process Eng., Staff	Cat. Constr.
Sun Oil Co.	Toledo, Ohio	Compressor Station	3,840 hp.		Designing			Fluor	
The Texas Co.	W. Tulsa, Okla.	Expand. Modernize Refinery	30,000 bbls.		Under Constr.	Indefinite		Kellogg, Foster-Wheeler, U.O.P.	Kellogg, Foster-Wheeler
The Texas Co.	Lawrenceville, Illinois	Expand Refinery	†20,000 bbls.		Design	April 1, 1951		Foster-Wheeler, Kellogg	Foster-Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumwright, Oklahoma	Houdriflow Unit Cat. Cracker	4,500 bbls.		Contracted		Houdry		Process Eng.
U. S. Dept. of Interior	Louisiana, Mo.	Demonstration Oil-from-Coal Plant	80 bbls.	$5 million	Under Constr.	Dec., 1949		Koppers	Koppers
West Cement Medrano Unit	Caddo County, Oklahoma	Gas Injection Facility	9,000 mcf	$1 million	Under Constr.	July, 1949		Dresser	Dresser
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Fluid Cat. Cracker	7,500 bbls.	$2.5 million	Under Constr.	Dec., 1949	U.O.P.	Koch	Staff
Wood River O&R Co.	Hartford, Ill.	Vacuum Unit	15,000 bbls.	$700,000	Under Constr.	August, 1949		Koch	Staff
SOUTHWEST									
*Alba Refg. Co.	Alba, Texas	Asphalt Refining	1,500 bbls.	$125,000	Under Constr.	Nov. 1, 1949			
Barnsdall Oil Co.	Placedo, Texas	Compressor Station	2,000 hp.	$380,000	Under Constr.	July, 1949		Olsen	Olsen
Brazos River Gas Co.	Mineral Wells, Texas	Gasoline Plant	15,000 mcf		Under Constr.	Sept., 1949		R. L. Purvin & Richard Henry	
The California Co.	Brookhaven, Mississippi	Cycling Plant	10,000 mcf			Completed		Hudson	Hudson
Calumet Refg. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.		Under Constr.	3rd Qtr., 1949		Staff	Stafff
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	$26 million	Under Constr.	Dec., 1949	Hydro-Res., Inc. Texaco	McKee, Hydro-Res., Inc.	McKee
Cit-Con Corp.	Lake Charles, La.	Lube Plant	6,000 bbls.	$42 million	Under Constr.	Sept. 1, 1949	Texaco Max B. Miller	Max B. Miller, Lummus	Lummus, Max B. Miller
Cities Service Oil Co.	Pampa, Texas	Gasoline Plant	18,000 mcf		Contracted	1949		Waico	Waico
Cities Service Oil Co.	Chico Field, Wise Co., Tex.	Natural Gasoline Plant	22,000 mcf		Designing	Early, 1950		Fluor	Fluor
Cities Service Oil Co.	St. Rose, La.	Lube Oil Blending	1,500 bbls.	$750,000	Under Constr.	Late 1949		Day & Zimmerman	Day & Zimmerman
Claiborne Gasoline Co.	Lisbon, La.	Enlarge Pipeline Absorption Plant	125,000 mcf			Completed		Pet. Eng.	
*Coastal Refineries, Inc.	McAllen Texas	Cycling Plant	50,000 mcfd		Under Constr.	Mar., 1950		Gaso. Plant	Gaso. Plant
Continental Oil Co.	McAllen, Starr County, Texas	Gasoline Plant Enlargement	20,000 mcf	$1.5 million	Under Constr.	Dec., 1949			
Continental Oil Co.	Todd (Deep) Field, Texas	Gas Recovery Plant	10,000 mcf		Under Constr.	Sept., 1949		Ref. Maint.	Ref. Maint.
Cosden Pet. Corp.	Big Spring, Tex.	Fluid Cat. Plant	6,000 bbls.	$2 million	Under Constr.	Nov., 1949	U.O.P.	U.O.P.	Ref. Eng.
Department of the Army	Houston, Texas	Anhydrous Ammonia Facility	2,100 tons monthly	$2.5 million	Relocating	Sept., 1949		Girdler Corp.	Hercules Powder Co.
El Paso Natural Gas Co.	Mohana Field, Texas	Gasoline Plant	16,700 mcf		Designing	1949		Fluor	Staff
El Paso Natural Gas Co.	Mohana Field, Texas	Treating Plant			Designing	1949		Fluor	Staff
E. I. DuPont de Nemours Co., Inc.	Victoria, Texas	Chemical Intermediates for Nylon			Design	Early 1951		Staff	Staff
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities		$40 million	Under Constr.	Oct., 1949		Stone & Webster	Stone & Webster
B. F. Goodrich Co.	Port Neches, Texas	Expand Plant		$800,000	Under Constr.			Staff	Carruth Constructing Co.
Gulf Oil Corp.	Crane, Texas	Gasoline Plant	40,000 mcf		Under Constr.	July, 1949		Braun	Braun, W. H. Bowden
*Gulf Oil Corp.	Port Arthur, Texas	Revamp Houdry Fixed-Bed Units	10,000 bbls.			3rd Qtr., 1949	Houdry	Houdry	Cat. Constr. Co.
Humble O&R Co.	Katy, Texas	Add Propane, Absorption, Refrigeration	Unchnaged		Under Constr.	Oct., 1949		Stearns-Roger	Stearns-Roger
Humble O&R Co.	Conroe, Texas	Absorption Facilities	30,000 mcf		Under Constr.	Oct., 1949		Stearns-Roger	Stearns-Roger
Humble O&R Co.	Opelousas, La.	Absorption Plant	110,000 mcf		Under Constr.	Sept.-Oct., 1949		Hudson	Hudson
Humble O&R Co.	Baytown, Texas	Pipe Stills	45,000 bbls.		Under Constr.	July, 1949		Foster-Wheeler	Foster-Wheeler
Humble O&R Co.	Baytown, Texas	Roof Replacing of Butyl Bldg.			Under Constr.			Staff	Staff
*Humble O&R Co.	Baytown, Texas	Misel. Facilities		$1 million	Projected				

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Humble O&R Co.	Jourdanton Field, Texas	Gasoline Plant	26,000 mcf		Under Constr.	Early 1950			Hudson
*Humble O&R Co.	Pickton Field, Texas	Absorption	18,000 million		Under Constr.				
Humble O&R Co.	Tomball Field, Texas	Additional Compression Facilities	10,000 mcf		Under Constr.	Sept., 1949		Fluor	Fluor
Hutex O. & R. Co.	Hardin, Texas	Fractionators for Solvents	1,000 bbls.	$50,000	Under Constr.	July, 1949		Staff	Staff
Jefferson Chem. Co., Inc.	Austin, Texas	Central Research Facilities			Under Constr.	Sept., 1949		Staff	Staff
Jefferson Chem. Co., Inc.	Port Neches, Texas	Increase Capacity			Engineer	1950		Staff	
Lone Star Gas	Dallas, Texas	Hypersorption Plant	60 mcf		Design & Eng.	1949	Union Oil Co.	Foster-Wheeler	Foster-Wheeler
Magnolia Pet. Co.	Kilgore, Texas	Increase Propane Recovery	Unchanged		Under Constr.	Aug., 1949		Staff, Delta	Delta
Magnolia Pet. Co.	Seeligson Field, Texas	Gasoline and Cycling	70,000 mcf Casinghead 150,000 mcf Cycled		Under Constr.	Sept., 1949		Hudson	Hudson
*Magnolia Pet.	Chitwood, Okla., (Grady County)	Gas Compression Plant	25,000 mcf		Under Constr.	Oct. 1, 1949		Staff, Delta	Constr. Serv Co.
*Mayfair Minerals, Inc.	McAllen, Tex.	Cycling Plant	50,000 mcfd		Under Constr.	Mar., 1950		Gaso. Plant	Gaso. Plant
Midland Gasoline Co.	Conroe Field, Texas	Enlarge Gasoline Plant	100,000 gals.		Under Constr.	Dec., 1949		Gaso. Plant	Gaso. Plant
Pan American Refining Corp.	Texas City, Tex.	Revamping Crude Unit			Engineering	Late 1949		Tellepsen	Tellepsen
Panhandle Producing & Refining Co.	Wichita Falls, Texas	Cat. Cracker	1,500 bbls.	$1 million	Under Constr.	March, 1950	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
Phillips Chemical Co.	Etter, Texas	Anhydrous Ammonia	170,000 tons year	$5.3 million	Under Constr.	July, 1949	Chem. Constr.	Chem. Constr.	Brown & Root
Plymouth Oil Co.	Rankin, Texas	Gas Compression, Absorp.	70,000 mcf	$5½ million	Under Constr.	1949-50			Hudson
The Pure Oil Co.	Nederland, Tex.	Wax Fractionation	200 bbls.		Under Constr.	Sept., 1949	Texaco	Lummus	Lummus
Shamrock Oil & Gas Co.	Sunray, Texas	Increase Topping & Cracking Facilities	10,000 bbls.	$300,000	Under Constr.	3rd Qtr., 1949	U.O.P.	Staff	Staff
Shell Chem. Co.	Houston, Texas	Extend Acetone Facilities				Completed		Braun	Braun
Shell Oil Co.	Houston, Texas	Lube Plant Utilities			Under Constr.	1949		Fluor	Fluor
Shell Oil Co.	Houston, Texas	Wax Finishing Unit			Under Constr.			Fluor	Fluor
Shell Oil Co.	Provident City, Texas	Gas Stripping Plant	50,000 mcf		Under Constr.	1st Qtr., 1950		Fluor	Fluor
Shell Oil Co.	Notrees, Texas	Extension TXL Plant	30,000 mcf		Under Constr.	Early 1950		Brown & Root	Brown & Root
Shell Oil Co.	Denver City, Texas	Gas Compression, Absorp. Addition	30,000 mcf		Under Constr.	Late 1949		Fluor	Fluor
Skelly Oil Co.	Skellytown, Texas	Expand Gasoline Plant			Under Constr.	Fall, 1949			J. E. Carlson
Southern Minerals Corp.	Stratton Field, Texas	Gas Compression addition			Under Constr.				
Stanolind O&G Co., Opr.	Fullerton Field, Texas	Gasoline Plant	55,000 mcf		Under Constr.	Jan., 1950		J. & L. Constr.	J. & L. Constr.
Stanolind O&G.	Brownsville, Tex.	Chemical Plant			Under Constr.	Jan. 1, 1950		Badger	Badger
Stanolind O&G.	Levelland Field, Texas	Gasoline Plant			Under Constr.	1950		Brown & Root	Brown & Root
Stanolind O&G.	N. Cowden, Tex.	Gasoline Plant	75,000 mcf		Engineering	1950		Stearns-Roger	Stearns-Roger
Sun Oil Co.	Starr Co., Tex.	Gasoline Plant	35,000 mcf	$4 million	Under Constr.	Sept., 1949	Pet. Eng.	Pet. Eng.	Pet. Eng.
Tex. Natl. Gas Corp. & Slick-Urschel Oil Co.	Rankin, Texas	Gasoline Plant	55,000 mcf		Under Constr.	Late 1949		Tex. Natl. Gas Corp.	Tex. Natl. Gas Corp.
The Texas Co.	Port Arthur, Texas	Lube & Wax Additions	137,500 Crude 12,500 bbls. Oil		Under Constr.	Mid., 1949		Foster-Wheeler	Foster-Wheeler
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	6,000 mcf		Under Constr.	Oct., 1949			
The Texas Co.	Chalk-Hill Field, Texas	Gas Compression, Absorp.	2,000 mcf		Under Constr.	August, 1949			
The Texas Co.	Withers Field, Texas	Expand Compression	9,000 mcf		Under Constr.	July, 1949		Tellepsen	Tellepsen
United Gas Pipe Line Co.	Karnes City, Texas	Natural Gas & Condensate Processing Plant	10,000 mcf.	$1 million	Under Constr.	Jan., 1950		Delta	Delta
West Texas Gas Co.	Fritch, Texas	Enlarge Compressor Station	3,150 B. hp.		Under Constr.	Aug., 1949		Staff	
ROCKY MOUNTAIN									
American Gilsonite Co.	Bonanza, Utah	Gilsonite to Crude Oil Pilot Plant	300 tons	$300,000	Under Constr.	July, 1949		Staff	Staff
The Carter Oil Co.	Billings, Mont.	Crude Cat. Crk.	30,000 bbls.	$15 million	Under Constr.	3rd Qtr., 1949		U.O.P., S.O.D., Fluor	Fluor
Continental Oil Co.	Billings, Mont.	Complete Ref. Cat. Crack	7,500 bbls.	$9.5 million	Under Constr.	Oct., 1949	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
*Coronado Gasoline Corp.	Artesia, N.M.	Enlarge Plant	10 million gals.	$400,000	Under Constr.	July, 1949	Pet. Eng., Inc.	Pet. Eng.	Staff
Empire State Oil Co.	Thermopolis, Wyoming	Crude, Vacuum Units	5,000 bbls.	$325,000	Under Constr.	July, 1949		Ref. Eng.	Ref. Eng.
Northern Natural Gas Co.	Palmyra, Neb.	Compressor Add.	1,600 hp.		Under Constr.	1949			Fluor
The Pure Oil Co.	Worland, Wyo.	Gasoline Plant			Projected				
Salt Lake Refining Co.	Salt Lake City, Utah	Cat. Cracking Units	25,000 bbls.	$10 million	Design	Jan., 1951			
Skelly Oil Co.	Lea County, N. M.	Expanding Gasoline Plant	60,000 gals.		Under Constr.	Mid., 1949			J. E. Carlson
Texas Gulf Sulphur Co.	Worland, Wyo.	Sulfur Recovery, Gas Treating Plants	30,000 mcf		Under Constr.			Girdler, C. F. Braun, Foster-Wheeler	Girdler
WEST COAST									
*Caminol Company	Santa Fe Springs, Calif.	Dismantling Refinery for Shipment to Antwerp, Belgium			Shipped				Barnes
General Pet. Corp.	Torrance, Calif.	H_2S Absorption Plant			Engineering	Jan., 1950		Badger	Badger
General Pet. Corp.	Torrance, Calif.	Noded Spheroid	2 million gal.	$400,000	Under Constr.	July, 1949		Staff	Chicago Bridge & Iron Co.

• CONTINUED ON PAGE 84

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
General Pet. Corp	Torrance, Calif.	Cooling Tower	8,400 gal.		Under Constr.	Aug., 1949		Staff	Fluor & Staff
General Pet. Corp	Torrance, Calif.	Chemical Treating Facility	2,000 tons		Under Constr.	Late Fall, 1949		Staff	Staff
Hancock Chemical Co.	Long Beach, Calif.	H_2S Recovery System	50 tons	$1 million	Designing	Jan., 1950		Badger	Badger
Hancock Oil Co	Long Beach, Calif.	Ethylene Glycol Unit	60,000 lbs.		Engineering	3rd Qtr., 1950		Badger	Badger
Hercules Powder Co	Hercules, Calif.	Ammonia Plant			Under Constr.	Summer, 1949		Staff	Bechtel
Ohio Oil Co.	S. Coles, Levee, Calif.	Gas Lift	1,800 hp.		Designing	1949		Fluor	Fluor
Richfield Oil Corp.	Cuyama, Calif.	Absorption H_2S Removal Plant	1,500 mcf		Designing	1949		Fluor	Fluor
Richfield Oil Corp.	Cuyama, Calif.	Compressor Plant Exten.	2,640 hp.		Designing	1949		Fluor	Fluor
Shell Oil Co.	Wilmington, Cal.	Extend Cracking Plant Compressors			Under Constr.	Middle 1949		Fluor	Fluor
*Socony-Vacuum Oil Co.	Los Alamitos, Calif.	Dismantling Refinery for Shipment to Naples, Italy				Completed			
Standard Oil Co. of Calif.	Bakersfield, Calif.	Thermal, Crk., Gaso. Stabil. Gaso. Treating	9,000 bbls.		Under Constr.	Late 1949	U.O.P.	U.O.P.	Braun
Standard Oil, Calif.	Bakersfield, Calif.	Crude Dist.	10,000 bbls.	$7.7 million	Under Constr.	Mid 1949	Braun	Braun	Braun
Standard Oil, Calif.	El Segundo, Cal.	Cracked Naphtha Rerun Still	22,000 bbls.	$2.6 million	Under Constr.	Aug., 1949		Braun	Braun
*Standard Oil, Calif.	Richmond, Calif.	Packaging and Grease Plant		$7 million		Completed		Staff	Bechtel
*Union Oil of Calif.	Brea Olinda, Calif.	Research Plant		$5 million	Projected	Sept., 1950			
Union Oil Co. of Calif.	Oleum, Calif.	Asphalt Refined Oil Loading Facilities		$457,000	Under Constr.	Sept., 1949		Early Constr.	Early Constr.
Union Oil Co. of Calif.	Oleum, Calif.	Revision of Refining Facilities		$4 million	Under Constr.	Oct., 1949		Parsons, E. & A.	Ref. Maint.
Union Oil Co. of Calif.	Oleum, Calif.	Improvements to Compound & Barrel Handling Facilities		$1.5 million	Under Constr.	Dec., 1949		Mathews Conveyor Co., J. M. Montgomery & Co.	Early, C. N., Peterson, Mathews Conveyor
Union Oil Co. of Calif.	Oleum, Calif.	Duo-Sol Unit	6,000 bbls.	$3 million	Under Constr.	Sept., 1949	Max Miller	Max Miller	Max Miller
Union Oil Co. of Calif.	Oleum, Calif.	Tankage and Utilities		$1.8 million	Engineering	1st Qtr., 1950		Parsons	Eaton & Smith, Chicago Bridge & Iron Works, Utah Constr. Co.
*Union Oil of Calif.	Oleum, Calif.	Main Office Addition, Shops, Misel. Bldgs.		$1 million	Under Constr.	4th Qtr., 1949		Austin, Field & Fry, D. R. Warren Co., J. M. Montgomery & Co. Parkhill-Wade	E. S. McKittrick, Parker, Steffens & Pearce
Union Oil Co. of Calif.	Brea Olinda, Calif.	Enlarge Absorption Facilities	†6,000 mcf		Posponed	4th Qtr., 1949			
FOREIGN									
Canada									
British-American Oil Co., Ltd.	Montreal East, Quebec	Crude Oil Topping and Decarbonizing Unit			Under Constr.	Sept., 1949			
British-American Oil Co., Ltd.	Montreal East, P.Q., Canada	Cat. Cracking and Cat. Poly	13,300 bbls.		Under Constr.	4th Qtr., 1949	Kellogg-U.O.P.	Kellogg	Kellogg
Excelsior Refineries	Lloydminster, Alberta, Canada	Moving Refinery	3,000 bbls.	$500,000	Under Constr.	Sept., 1949	U.O.P.	U.O.P.	
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Crude Topping Unit	2,000 bbls.		Under Constr.	Dec., 1949	U.O.P.	Ref. Eng.	Ref. Eng.
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Thermal Cracking Unit	500 bbls.		Under Constr.	Dec., 1949	U.O.P.	Ref. Eng.	Ref. Eng.
Imperial Oil, Ltd	Edmonton, Canada	Increase Capacity	15,000 bbls.	$2½ million	Under Constr.	July, 1949		Staff, Barnes	Barnes
Imperial Oil, Ltd	Leduc Field, Canada	Gas Absorption Plant	24,000 mcf	$6.5 million	Under Constr.	Middle 1950		Braun	Braun
*Imperial Oil	Regina, Saskatchewan, Canada	Restore Capacity	15,000 bbls.	$380,000	Under Constr.	Jan., 1950		Staff	Staff
Panther Oil and Grease Co.	Leaside, Toronto, Canada	Grease and Compounding Plant			Projected				
Shell Oil Co. of Canada, Ltd.	Montreal, East Quebec, Canada	Fluid Cat. Cracker, Vac. Flashing, Gas Recovery, Polymer, Treating	35,000 bbls.		Under Constr.	Late 1950		Staff	Fluor, Ltd., McKee
Latin American									
Companhia Brasileira de Petroleos, S.A.	Rio Grande, Brazil	Topping, Thermal Cracking	3,000 bbls.		Authorized	1952	Foster-Wheeler		
Conselho Nacional do Petróleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	2,500 bbls.	$2.5 million	Under Constr.	Jan., 1950		Kellogg	Kellogg, Staff
Conselho Nacional do Petróleo		Thermal Cracking Refinery	45,000 bbls.		Design	1952			Fives, Lille, Schneider, Staff
Creole Pet. Corp.	Amauy Bay, Venezuela	Crude Stills	60,000 bbls.	$175 million	Under Constr.	1951		S.O.D.	Foster-Wheeler J. G. White
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring			Planning				
Mene Grande Oil Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.						
Petróleos Mexicanos	Poza Rica, Mex.	Gas Purification, Pressure Maintenance, etc.		$13 million	Contracted	Early, 1950		McKee	McKee
Petróleos Mexicanos	Salamanca, Mex.	Crude, Gasoil, Cracking	30,000 bbls.	$12 million	Under Constr.	Early, 1950	U.O.P.	McKee	McKee
Refinaria de Petróleo do Distrito Federal S.A.	Rio de Janeiro, Brazil	Complete Refinery	10,000 bbls.		Authorized				
Refinaria e Exploracao de Patróleo	Capuava, S. Paulo, Brazil	Thermal Cracking Refinery	20,000 bbls.		Authorized			Pan American Hydrocarbon Res., Inc.	Czech, Fact. Metal Work & Mech. Constr.
Richmond Exploration Co.	Lake Maracaibo, Venezuela	New Refinery	35,000 bbls.		Engineering	June, 1950			

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REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Shell Oil of Venezuela	Cardon, Venezuela	Comprehensive Refining	50,000 bbls.		Under Constr.	Mid 1951			
Venezuela Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.		Under Constr.	July, 1950		Lummus	Lummus
Venezuelan Pet. Co. (Sinclair)	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Frederick Snare Corp.	Ffrderick Snare Corp.
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.		Engineering	Late, 1950		Kellogg	Kellogg
Yacimientos Petroliferos Fiscales	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.8 million	Under Constr.	Mid 1949		Houdry Process Cat. Constr.	Cat. Constr.
Yacimientos Petrolejeros Fiscales Bolivianos	Sucre, Bolivia	Crude Plant	3,000 bbls.			2nd Qtr., 1949		Foster-Wheeler	Foster-Wheeler
YPF Bolivianos	Cochabamba, Bolivia	Topping & Reforming Units	5,000 bbls.			1st Qtr., 1950		Foster-Wheeler	Foster-Wheeler
Europe and Africa									
Agwi Pet. Corp.	Fawley, Eng.		120,000 bbls.	$140 million	Projected	1952			
Anglo-American Oil Co.	Fawley, Eng.	Refinery Expansion	110,000 bbls.	$130 million	Under Constr.	Late 1952		Foster-Wheeler	Foster-Wheeler
Anglo-Iranian Oil	Isle of Grain, Thames and Medway Estuary, Eng.	Wax Fractionation	60,000 bbls.	$120 million	Planning	1952	Texaco (Lube Unit)	Lummus	Lummus
Anglo-Transvaal Consolidated Investment Co.	Vall River Union, South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydrocarbon Research	
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected				
Azienda Generale Italiana Petroli	Palermo, Italy	Marine Fuel Plant	7,500 bbls.						
*Bataafsche Pet. My.	Pernis, Holland	Expansion	50,000 bbls.		Under Constr.	Mid 1952			
Cabot Carbon, Ltd. Godrefy L. Cabot, Inc.	Ellesmeres Port, Cheshire, Eng.	Carbon Black Plant	50,000 lbs.		Under Constr.	1950		Simon-Carves, Ltd.	Simon-Carves, Ltd.
Caltex & Spanish Associate	Cartagena, Spain	Refinery	15,000-20,000 bbls.		Proposed	March, 1951			
Caltex Pet. Maatschappij, N. V.	Rotterdam, Holland	Complete Refinery	20,000 bbls.	$18 million	Under Constr.	Feb., 1950		McKee, Badger, U.O.P.	McKee
Cie. de Raffinage Shell-Berre	Berre, France	Expansion	40,000 bbls.		Under Constr.	Mid 1951			
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Projected	1951	Texas	Kellogg-Lummus	
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	1950		Foster-Wheeler	Foster-Wheeler
Cie. Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.		Under Constr.	1950		Foster-Wheeler	Foster-Wheeler
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
Compania Espanola de Petroleos S. A. (C.E.P. S.A.)	Canary Islands, Spain	Furfural Refining, Solvent Dewaxing Wax Fractionation Units	5,000 bbls.	$4½ million	Under Constr.	Early 1950	Texaco, Standard, N. J.	Foster-Wheeler	Foster-Wheeler
Conselho Nacional do Petroleo		Thermal Cracking Refinery	45,000 bbls.		Design	1952			Fives, Lille, Schneider, Staff
Danish Government	Denmark	Refinery	21,000 bbls.		Planned				
Egyptian Government	Cairo, Egypt	Crube Plant						Lummus	Lummus
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,500 bbls.						
Industria Nazionale Petroli e Trasformazione	Massa Carrara, Italy	Refinery	40,000 bbls.						
*Industria Petrolifera e Chimica	Milan, Italy	Gasoline, Fuel Oil Plant	1 million tons					Dr. Calogero Inglogio	
Italo-American Esso-Anie	Leghorn, Italy	Capacity Increase	28,700 bbls.						
Italo-American Esso-Anie	Bari, Italy	Capacity Increase	38,300 bbls.						
L'Alliance Petrofina	Antwerp, Belgium	Refinery	21,000 bbls.		Planned				
Manchester Oil Refinery, Ltd.	Partington, England	Cat. Crk., Lube, Reforming	20,000 bbls.		Projected				
Monsanto Chemical Co.	Britain	Add Polystyrene			Design	Early 1950		Staff	Staff
National Oil Refineries, Ltd.	Llandarcy, Wales	Crude and Reform	40,000 bbls.	$36 million	Designing			Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	1,200 bbls.				Texaco	Badger	Badger
National Oil Refineries.	Llandarcy, Wales	SO_2 Solvent Extraction	3,000 bbls.		Contracted			H. W. P.	
Pechel-Bronn, S.A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.		Authorized	1950			
Petro Carbon, Ltd.	Partington, England	Cat. Cracker, Lube & Reform	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petro Chemicals	2,000 bbls.	$16 million	Under Constr.	1949	Petro-Carbon	Petro-Carbon	Petro-Carbon
Philblack, Ltd.	Avonmouth, England	Carbon Black Plant	50 million lbs. Yearly	$5 million	Contracted	1950	Phillips	H. W. P.	H. W. P.
Porto Marghera Refg.	Venice, Italy	Enlarging Crude Unit			Contracted			H. W. P.	H. W. P.
*Raffinerie Beige de Petroles S.A.	Antwerp, Belgium	Thermal Crack., Reforming and Gas Plant		$2 million	Under Constr.	Late 1949		Barnes	Barnes
Raffineries de Petrole de la Gironde	Ambes, France	Refinery	13,000 bbls.	$7.8 million	Reconstr.	Early 1950		U.O.P., McKee	McKee
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.						
Raffineria di Napoli, S. P. A.	Naples, Italy	Topping Unit	15,000 bbls.		Under Constr.	Late 1949		Staff	Staff
Raffineria di Napoli	Naples, Italy	Solvent Treating	1,000 bbls.		Under Constr.	Early 1950	Texaco	Staff	Staff
*Raffineria di Napoli	Naples, Italy	Reformer	5,000 bbls.		Under Constr.	Early 1950		Staff	Staff
Raffinerie Siciliane Oli Minerali, S.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.		Designing	Early 1950	U.O.P.	U.O.P., Delta	S. T. I. I.
Scottish Oils, Ltd.	Grangemouth, Scotland	Crude	28,000 bbls.	$28 million	Designing			Kellogg	Schneider
Scottish Oils, Ltd.	Grangemouth, Scotland	Cat. Crk.	5,000 bbls.		Planned				
*Shell-Berre	Petit-Couronne (Rouen), France	Expansion	10,000 bbls.		Under Constr.	Early 1950			

* CONTINUED ON PAGE 89

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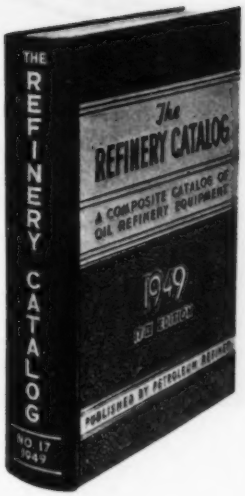

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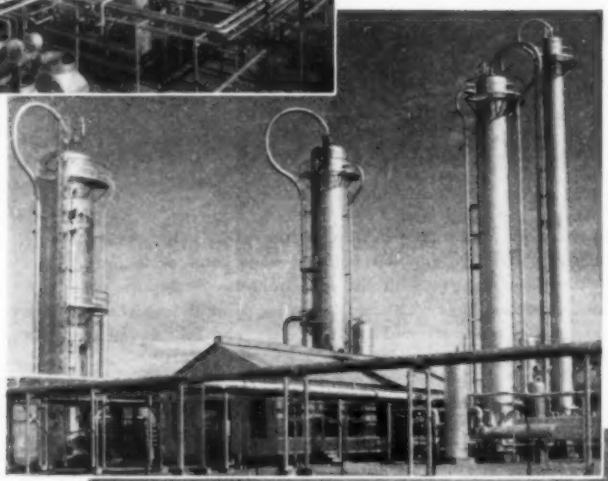

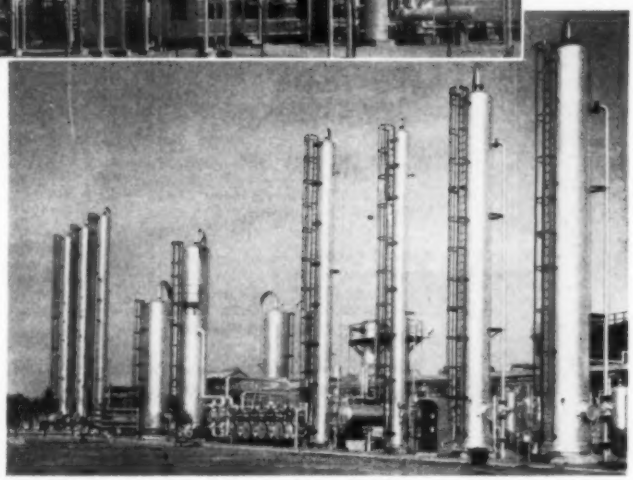

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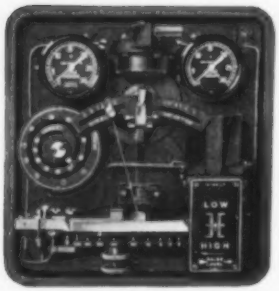
REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

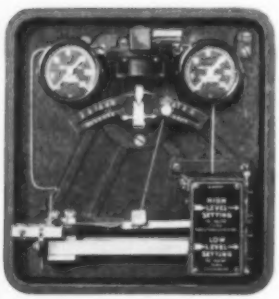
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Chem. Corp.	Thornton, Eng.	Petro-chem	.....	Several millions	.....	Completed	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Stanlow, Eng.	Comprehensive Refining	50,000 bbls.	.....	Under Constr.	Early, 1952	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Comprehensive Refinery	65,000 bbls.	.....	Under Constr.	Mid., 1953	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Hamburg-Harburg, Germany	Refinery	8,950 bbls.	.....	Under Constr.	Late 1949	.....	.....	.....
Société Generale des Huiles de Petrole	L'Avera, France	LPG Units	.....	.....	Under Constr.	Mid 1950	Kellogg	Kellogg	Staff
Société Generale	Dunkirk, France	Crude Reform.	33,000 bbls.	.....	Under Constr.	Mid 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Société Generale	Dunkirk, France	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	2,400 bbls.	.....	Designing	Mid 1951	Texaco	Lummus	Lummus
Societe Industriel Belgique de Petrele	Antwerp, Belgium	Crude, Cracking Reforming	30,000 bbls.	.....	Designing	Mid 1951	.....	.....	.....
Societa per Azioni Raffineria Padana Olii Minerali	San Martino di Trecate, Italy	Refinery	13,000 bbls.	.....	Proposed	.....	.....	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Contact Plant	.....	.....	Under Constr.	Mid 1949	.....	Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	MEK Unit	1,000 bbls.	.....	Design	Mid., 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Propane Deasphalting	1,100 bbls.	.....	Design	Mid 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Furfural Unit	1,000 bbls.	.....	Under Constr.	Mid 1949	Texaco	Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Grease and Compounding Plant	.....	.....	Under Constr.	Mid., 1949	.....	Staff	Staff
Socony-Vacuum Francaise	Frontignan, France	Capacity Increase	13,500 bbls.	.....	Under Constr.	Completed	.....	Staff	Staff
Standard Francaises des Pétroles	Port Jerome, France	Capacity Increase	30,000 bbls.	.....	Authorized	.....	.....	.....	.....
Standard Francaises des Pétroles	Port Jerome, France	Dewaxing Plant	1,000 bbls.	.....	Planned	.....	.....	.....	.....
Standard Francaises des Pétroles	Port Jerome, France	Deasphalting Plant	2,000 bbls.	.....	Planned	.....	.....	.....	.....
Standard Oil Co., N.J.	Belgium	Refinery	33,000 bbls.	.....	Planned	1952	.....	.....	.....
Koppar-Trans Co.	Goteborg, Sweden	Crude, Ther. Cracking	12,500 bbls.	.....	Under Constr.	Mid 1949	.....	Lummus	Lummus
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4 to $8 million	Plans approved	.....	.....	.....	.....
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery	.....	$20 million	Projected	.....	.....	.....	.....
Near East									
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950	.....	Badger	Badger
Anglo-Iranian Oil	Abadan, Iran	Cat. Cracker	30,000 bbls.	.....	Under Constr.	.....	.....	Foster-Wheeler	Foster-Wheeler
Anglo-Iranian Oil	Abadan, Iran	Solvent Dewaxing	400 bbls.	.....	Under Constr.	.....	Texaco	Badger	Badger
Arabian American Oil Co.	Saudi Arabia	H_2S Treating Plant	1,500 mcf	.....	Designing	1949	.....	Fluor	.....
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4,800,000	Under Constr.	July-Sept., 1949	.....	Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Steam Power Plant, etc.	20,000 kw	$9,400,000	Under Constr.	July-Sept., 1949	.....	Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Add Power Generating Unit	10,000 kw	$1,750,000	Under Constr.	July-Sept., 1949	.....	Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Refinery Additions	.....	.....	Under Constr.	1949	.....	Bechtel	Bechtel
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Add Power Generating Unit	10,000 kw	.....	Under Constr.	1949	.....	Staff, Fluor	Staff, Fluor
Bahrein Pet. Co., Ltd.	Bahrein Island	Expansion Program	.....	$8.3 million	Under Constr.	Oct., 1949	.....	U.O.P., Bechtel	International, Bechtel, Inc.
Bahrein Pet. Co., Ltd.	Bahrein Island	Crude Still, Utilities	55,000 bbls.	$9.1 million	Planned	June, 1950	.....	Lummus, Bechtel	.....
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.	.....	Planned	1950	.....	Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	General Facilities	.....	.....	Under Design	.....	.....	Badger, Ltd.	.....
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.	.....	Designing	.....	Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Kuwait Oil Co.	Kuwait	Topping Unit	20,000 bbls.	$2 million	Under Constr.	July, 1949	.....	Badger	Badger
Far East									
*Bataafsche Pet Mij (Shell)	Balikpapan, Borneo, East Indies	Expansion	42,000 bbls.	.....	Under Constr.	Mid., 1952	.....	.....	.....
Burmah Oil Co.	Burma	Furfural Plant Solvent Dewaxing, Wax Manufacturing Units	1,000 bbls.	$600,000	Designing	.....	Texaco	Badger	.....
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Design	1949	Max Miller, Socony-Vacuum	Max Miller	.....
Oceania									
*Australian Shell Oil Co.	Clyde, New S. W., Australia	Luboil Refining	250 bbls.	.....	Under Constr.	.....	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	.....	$4.8 million	Under Constr.	1951	.....	.....	.....
*Australian Shell Oil Co.	Geelong, Victoria, Australia	Bitumen and Luboil Plant	.....	.....	Projected	.....	.....	.....	.....
*Australian Shell Oil Co.	Geelong, Victoria, Australia	Asphalt, Lube Solvent Extraction Plants	.....	.....	.....	.....	.....	.....	.....

NOTE: Badger—E. B. Badger and Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Root—Brown & Root Construction Co. Cat. Constr.—Catalytic Construction Co. Chem. Constr.—Chemical Construction Co. Clarke—Clarke Construction Co. Constr. Service.—Construction Service Co. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. E. & A.—Ehrhart & Arthur, Inc. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster-Wheeler—Foster-Wheeler Corp. Gaso. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H. W. P.—Head Wrightson Processes, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J. & L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mason—Mason Brothers Construction Co. McKee—Arthur G. McKee Co. Max Miller—Max B. Miller & Co. Parsons—The Ralph M. Parsons Co. Pet. Eng.—Petroleum Engineering, Inc. Petro—Petroleum Rectifying Co. Pritchard—J. F. Pritchard Co. Process Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust Eng.—Rust Engineering Co. S. O. D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Tellepsen—Tellepsen Construction Co. Texaco—Texaco Development Co. U. O. P.—Universal Oil Products Co. Walco—Walco Engineering Wohfeld—Wohfeld Construction Co. Equally owned by California Texas Corp. and Socony-Vacuum Oil Co., Inc.

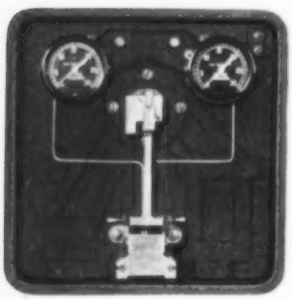


12610 Proportional-Reset Controller

12620 Pneumatic Transmitter



12630 Two-Position Differential-Gap Controller



12000-15 Three-Position Pneumatic Signal Switch

Versatility+ *in the* 12,000 Series

LEVEL CONTROLLER MECHANISMS

The **12000** Series Level Controllers (variable displacement) are available in a wide range of models designed to meet the requirements of specific applications. Incorporated in the four models illustrated are the basic mechanisms of the series.

The **12610** Proportional plus Reset Controller is used when maximum vessel surge capacity is wanted at all times in the presence of sustained load changes. It combines proportional-position action with proportional-speed floating action.

The **12620** Pneumatic Transmitter transmits level in terms of output pressure to any type remote receiver, or to a pneumatic switch for the operation of signal lights or other electrical devices. It has proportional-position action with 100% proportional band.

The **12630** Two-Position Differential-Gap Controller meets process requirements where proportional action is undesirable or to reduce wear on a valve or pump resulting from continuous or frequent operation. It combines two-position action with differential-gap.

The **12000-15** Three-Position Pneumatic Signal Switch Controller provides remote indication or control of level by actuating signal lights or other electrical devices when either of two predetermined limits is reached. It has three-position indication or on-off control.

CONTROLLER MOUNTINGS

Mountings for the 12000 Series controller are equally flexible; easily adapted to unusual or special vessel requirements with a wide selection of type, material, chamber rating and level ranges.

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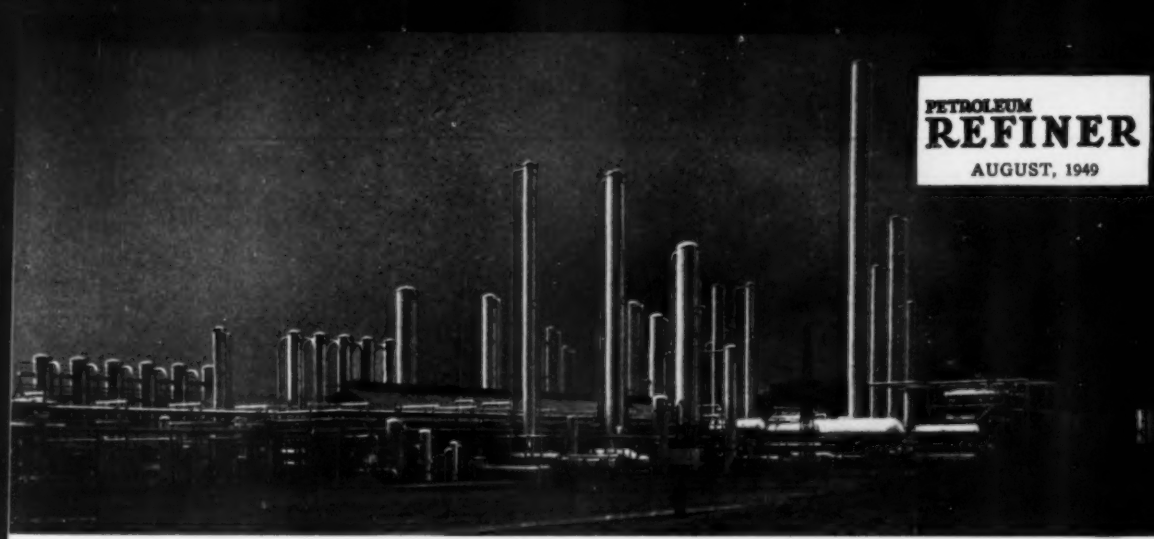
PETROLEUM
REFINER
AUGUST, 1949



Process area of the Feazel and Kinsey plant near Carthage, Texas, which processes 210 million cubic feet daily of natural gas to produce 7000 barrels of products.

Feazel and Kinsey Plant Employs Unusual Design

ROY A. SCHUSTER and ROBERT M. STEWART
The Chicago Corporation, Corpus Christi, Texas

RECENTLY completed additions to the Feazel and Kinsey plant in the Carthage field, Panola County, Texas, include an unusual combination of oil absorption, refrigeration and dehydration in the enlargement program.

The new plant incorporates the use of low molecular weight oil with refrigeration and dehydration before high-pressure absorption. The oil circulation is thereby reduced considerably under that required by high-pressure plants using high molecular weight oil. This results in the reduction in size of oil coolers, exchangers, vent tanks, stills and pumps. Also, the stripping of the oil is accomplished at a lower temperature than that required for conventional plants. A bottom temperature of 405° is carried on the main still, whereas it is necessary to carry 490° when using high molecular weight oil. The lowering of the temperature reduces the size of oil exchanger equipment and heaters.

***CONSTRUCTION** has just been completed on additions to the Feazel and Kinsey plant in East Texas, a plant now designed to process 210 million cubic feet daily, recovering 60 percent of the propane and substantially all the heavier hydrocarbons, for a total of 7000 barrels per day production. Gas handling equipment was designed to process an additional volume of gas at a reduced propane recovery percentage.*

The unusual design of this new plant, employing refrigeration and low molecular weight oil, which permits low oil circulation rate, has reduced the investment 50 percent under that required for a conventional plant having the same capacity and recovery.

By using refrigerated oil, the selectivity of absorbing propane at high pressures is increased, and the pick-up of methane and ethane is materially reduced. This simplifies the separation of ethane from propane and reduces the size of the reabsorbers, condensers and recompressors.

The high-pressure wet gas is gathered from the properties of the owners and others in the Carthage field. The flowing pressure on the wells is approximately 2200 pounds. This pressure is reduced at the well through adjustable chokes to approximately 1400 pounds, at which pressure it enters the plant. After passing through the cooling tower, the pressure is further reduced to 1050 pounds, which is the normal operating pressure of the plant.

The flow of gas through the high-pressure absorption equipment in the original plant was conventional. After a reduction in pressure the gas flowed through an inlet separator where the distillate dropped out; the gas then passed through the high-pressure absorbers where the gasoline was removed, and through a residue scrubber and the dehydration plant. The solid packed type towers are used in the dehydration plant for the removal of water. Due to the low temperature required for the new plant, hydrates would form if the water were not removed prior to absorption. Consequently, the gas flow was modified in the new plant. The gas now flows through the inlet separators direct to the dehydration plant, and then through the high-pressure absorbers and residue scrubbers to the sales gas line. No stripping steam is used in the low-pressure still, which results in dry oil being used over the absorbers; therefore, the dehydrated gas does not pick up any water as it passes through the absorbers.

Figure 1 shows the distillate fractionation flow diagram. The distillate collected in the inlet separator passes to a 550-pound distillate flash tank, then to a 250-pound flash tank. Water is pumped into the distillate immediately before it enters the 250-pound tank, in order more effectively to remove the salt. The salt water is removed through a bootleg and the distillated is pressured through an exchanger and preheater into the distillate fractionator. This tower operates at 160 pounds. Gasoline and lighter are taken overhead and run through an aftercooler to the deethanizer feed surge tank. The bottom product from the distillate fractionator, which consists of naphtha and heavier, passes to the naphtha fractionator.

This naphtha tower operates at about 10-pounds pressure. The overhead product from this tower is naphtha,

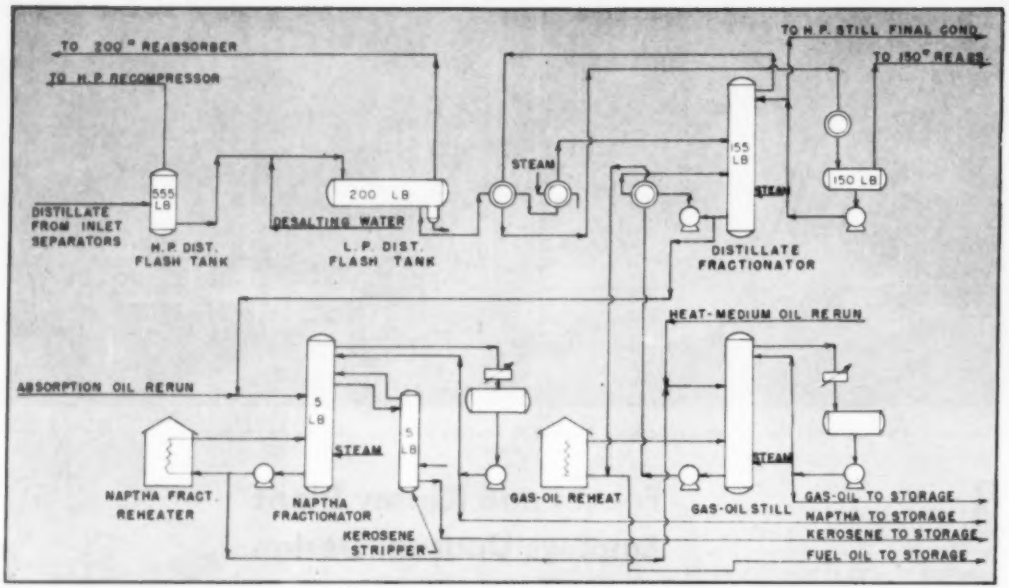


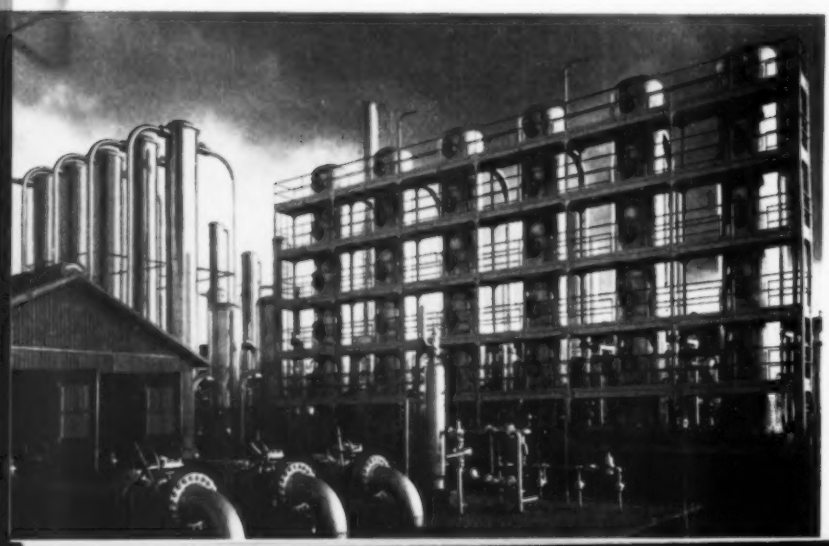
Figure 1. Distillate Fractionation Flow Diagram.

which may be either marketed as naphtha, or blended with the gasoline to raise the end point. Kerosine is taken as a cut off the side of this tower through a kerosine side stripper. The gasoil and heavier produced from the bottom of the naphtha fractionator goes to an oil purifying still. Stripping steam is used in both the naphtha fractionator and kerosine stripper. The heating of the bottom is accomplished by circulating the oil through a direct fired heater. This column also serves the purpose of purifying the absorption oil. A small stream of absorption oil is taken from the system continuously and passes into the fractionator where the heavy ends are removed along with the gasoil as bottom product. The kerosine make-up to the absorption oil system is taken from the kerosine side stripper.

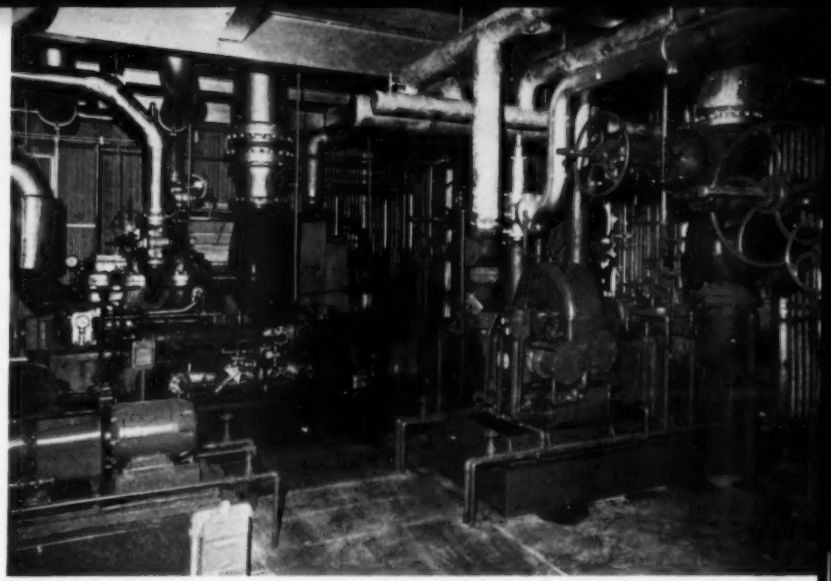
The gasoil which enters the oil purifying still is further fractionated, water white absorption oil being produced overhead and heavy fuel oil from the bottom. A direct-fired heater is used to supply heat to the bottom of this still. The tower is also used to condition the heating medium oil in the same manner as the naphtha fractionator is used to purify the absorption oil.

Figure 2 shows the process flow through the absorbers and distillation equipment. Due to the increased load and higher efficiency of the new plant, it was necessary to install additional vent tanks and stills. All of the original equipment was used as much as possible, and new equipment was installed to operate in parallel. As the oil leaves the five main absorbers it is split into two streams of equal volume. One stream passes through the original or No. 1, 550-pound flash tank, through the No. 1, 200-pound vent tank and through one section of the exchangers into a new 175-pound hot vent tank. The other stream of oil leaving the absorbers passes through new No. 2 vent tanks, which operate at the same pressure as the No. 1 vent tanks, and through the other half of the exchangers. The two oil streams are mixed in the hot rich oil vent tank.

Vapors from this vent tank pass through a water-cooled



Absorption and dehydration area. Two new absorbers were added to the row of columns at the left to increase the gas handling capacity of the plant from 125,000,000 to 210,000,000 cubic feet per day.

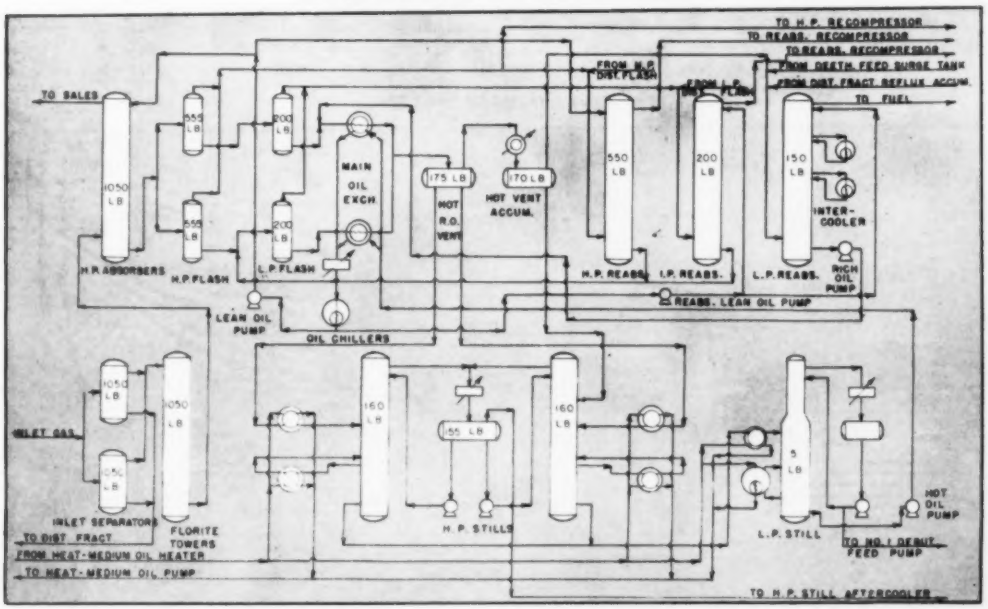


Interior of refrigeration and distillation pump building, showing heating medium circulating pumps foreground and the centrifugal propane compressor for the entire refrigeration load in the background.

condenser into an accumulator tank. The liquids from this tank pass to the top trays of one of the high-pressure stills where it acts as partial reflux, and the vapor goes to the 150-pound reabsorber. The oil from this hot vent tank is divided into two equal streams; one stream passing through a pre-heater into the original, or No. 1 high-pressure still, and the other stream passing through a new pre-heater into the No. 2 high-pressure still. Both of these stills operate at the same pressure, 160 pounds. The overhead from both of these stills goes to an accumulator, then through an after-cooler to the deethanizer feed surge tank where it is mixed with the distillate fractionator overhead. The oil from the bottom of both high-pressure stills is again mixed and goes to one low-pressure still. The overhead product from this low-pressure still, consisting of partially debutanized natural gasoline, is mixed with other liquids and pumped into the No. 1 debutanizer. The oil from the bottom of the low-pressure still is pumped with a hot lean oil pump through the exchangers, through cooling sections located in the original cooling tower, through an oil chiller where the temperature is reduced to 60°. A portion of this oil is pumped over the 200-pound and 150-pound reabsorbers and the remainder is then picked up by a high duty oil pump where it is passed over the high pressure absorbers, completing the cycle. A small part of this oil is passed over the 550-pound reabsorber.

Figure 3 shows the process flow of the fractionation equipment. As the original equipment did not have adequate capacity to handle the increased volumes of gasoline and lighter, a complete fractionation installation was made in duplicate to operate in parallel with the original. In the original installation the liquids were first passed to the No. 1 deethanizer where ethane was taken overhead. The product from the bottom of this tower then passed to the No. 1 debutanizer. The bottom product from this vessel was specification motor fuel with the desired vapor pressure and end point.

Figure 2. Process Flow Absorption and Distillation.



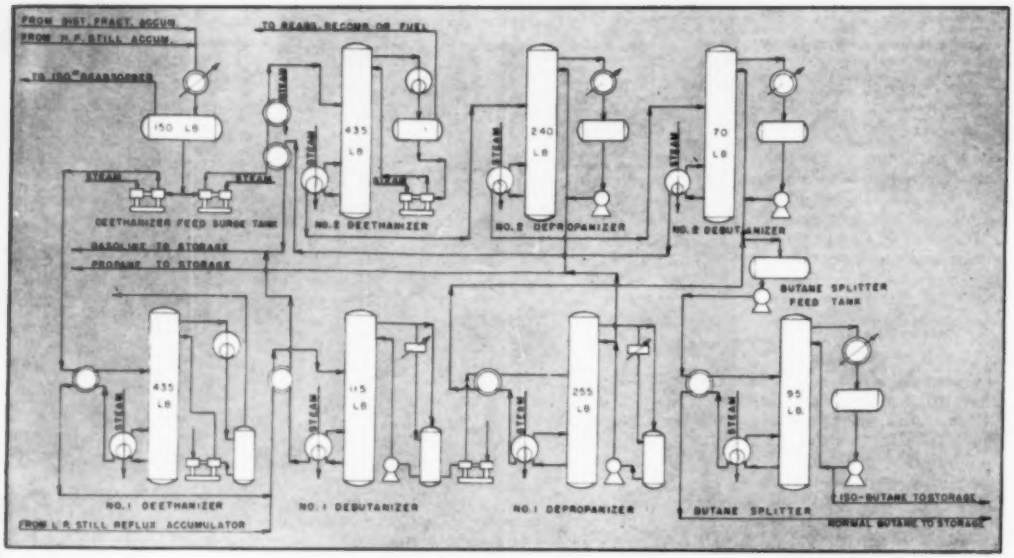


Figure 3. Process Flow Light Ends Fractionation.

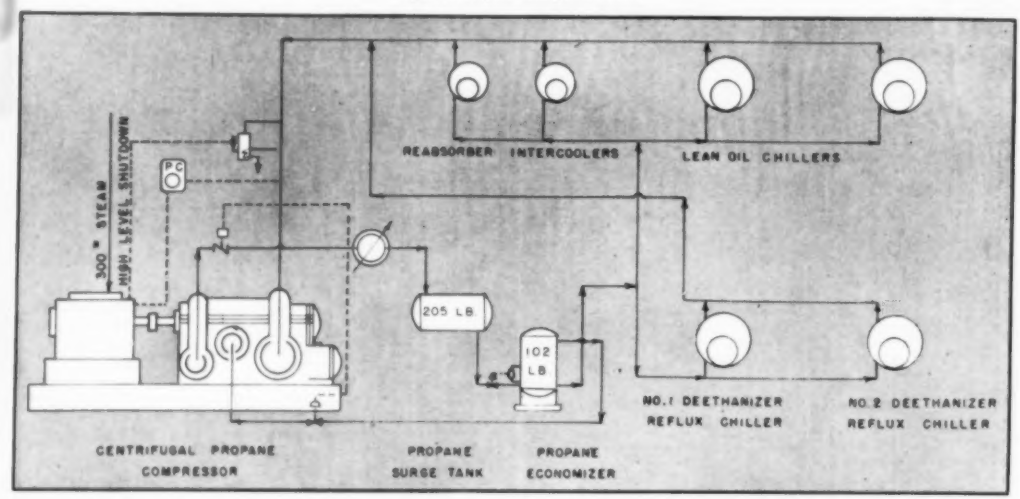
The overhead from the debutanizer was then pumped to the depropanizer where propane was taken overhead and butane from the bottom, both products going direct to storage. No changes were made in this part of the equipment, and it is being operated as originally installed.

As previously outlined, the overhead products from the distillate fractionator and both high-pressure stills are mixed in the deethanizer surge feed tank. This liquid is processed in two separate streams. One stream goes to the No. 1 deethanizer and is processed as set forth in the preceding paragraph. The other stream goes to the new fractionating equipment. This is a cascade type in which gasoline production passes through the columns in series. The liquid first goes to the No. 2 deethanizer where ethane is taken overhead. The bottom product is pressured into the No. 2 depropanizer where propane is taken overhead. The bottom product is pressured into the No. 2 debutanizer where the mixed butanes are taken overhead. The bottoms of this debutanizer are mixed with the bottoms of the No. 1 debutanizer, and with the naphtha from the naphtha fractionator and blended into specification motor fuel.

The mixed butanes from both the debutanizers are mixed in a butane surge tank and pumped to a butane splitter. This tower contans 65 trays and is approximately 145 feet tall. Very efficient separation is made in this vessel which produces iso-butane overhead and normal butane from the bottom.

The pressure controls on the No. 2 depropanizer, debutanizer and butane splitter are somewhat new in gasoline

Figure 4. Propane Refrigerant Flow.



plant design. The conventional back-pressure regulator on the overhead vapor line is not used. Instead the pressure of the tower actuates a regulator on the warm water leaving the shell and tube type condenser on the overhead vapor line. As the pressure of the liquid is a function of the temperature, controlling the temperature of the accumulator liquid controls the pressure on the system. The tower and the accumulator operate at the same pressure, the only difference being due to friction loss through the piping and condenser. Likewise, the top temperature of the tower is less than 10 degrees of the accumulator temperature. This operation has proved satisfactory and permits close control.

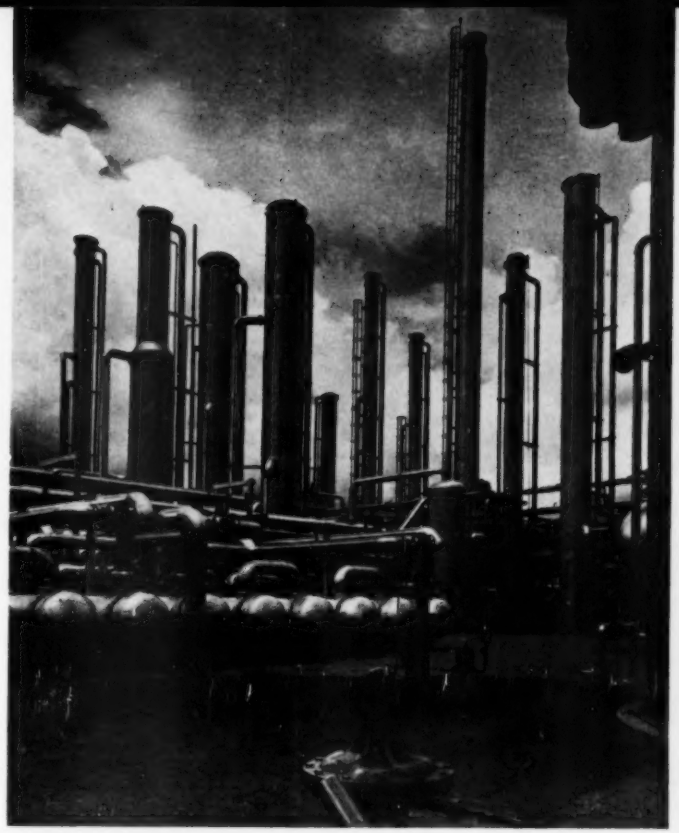
As previously shown, the overhead from the distillate fractionator is mixed with the overhead from both high-pressure stills, and passes through an aftercooler to the deethanizer feed surge tank. The vapors from this tank are mixed with the vapors from the hot rich oil vent tank accumulator and distillate fractionator accumulator and pass through the 150-pound reabsorber.

Another Cooling Tower

The increased load on the plant necessitated the installation of another cooling tower. The original cooling tower contained a coil shed, and all cooling was accomplished through open sections placed in the bottom of the tower. However, in the new plant all cooling is done in shell and tube type condensers. The new cooling tower does not contain a coil shed, the water being pumped from the basin of the tower through the various shell and tube type condensers and back over the top of the tower.

The condensers, accumulator tanks and pumps for all of the new fractionation equipment are located on a three-deck structure. The overhead vapor line from the tower passes to the condenser on the top deck, the liquid drops down into the accumulator tank located on the second deck and then to the pumps handling the reflux and feed, which are located at ground level. Locating the equipment in this manner provides sufficient NPSH for pumps, and due to the much shorter lines, permits closer control of the column operation.

Direct-fired heaters were used in the original plant to heat the absorption oil. For use in the new plant, these heaters were converted to the heating medium cycle. Gasoil is pumped through these heaters where the temperature is raised to approximately 500°, then through the various preheaters and reheaters into a surge tank. The circulating pumps take suction from this surge tank, which completes this cycle. This heating medium oil is used in the preheaters and reheaters of both high-pressure stills and the low-pressure still.



In the left foreground are the oil to oil exchangers. The columns shown in the picture (left to right) are as follows: Low pressure reabsorber, low pressure still, two high pressure stills, debutanizer, depropanizer, deethanizer, deisobutanizer (height 140 feet), high pressure reabsorber, and the intermediate pressure reabsorber.

Chilling of the various streams is accomplished by using propane as the refrigerant. Figure 4 shows the process flow. Refrigeration is used on the oil to the main absorbers and reabsorbers, for the inner-coolers on the 150-pound reabsorber and for the overhead on both deethanizers. A centrifugal compressor is used with a turbine drive, which gives considerable flexibility in speed variations. The unit being used is rated at 1400 h.p. and operates at a speed of 7600. The propane system is conventional. All chillers are of the kettle type with U bundles. The propane vapors leaving each chiller are controlled by individual regulators, which permits control of the temperature separately on each unit. The vapors are returned directly to the compressor and discharged to water-cooled condensers. The liquid propane is accumulated in the surge drum and is flashed in an economizer at a lower pressure before passing through the various chillers. Vapors from this economizer pass to the second wheel of the compressor, resulting in a saving of horsepower requirements.

In the distillate fractionation and oil absorption sections of the plant there are two 550-pound rich oil vent tanks and one 550-pound distillate flash tank. The vapors from these three vent tanks are combined into one stream. The original recompressor picks up a sufficient part of these vapors to load the engine, and compresses them to 1050 pounds into the inlet of the absorbers. The remainder of this gas which this recompressor will not handle passes through a 550-pound reabsorber. This residue gas is compressed with a second-stage cylinder on a new residue gas recompressor and is pumped directly into the main residue line from the plant. Likewise, all of the vapors from the two 200-pound cold rich oil vent tanks and the 250-pound distillate flash tank are combined into one stream and pass

This view shows the light ends fractionating area with the new equipment and towers located in the right foreground.

through a 200-pound reabsorber. The oil from these two reabsorbers joins the main oil stream before entering the exchangers. The residue gas from the 200-pound reabsorber and the overhead vapors from the two deethanizer reflux accumulators are compressed in the first stage of the new reabsorber recompressor and then mixed with the residue gas from the 550-pound reabsorber; the second stage of this recompressor pumps all this gas into the main residue gas line. All of the residue gas from the 150-pound reabsorber is used for fuel. The make-up is furnished from the 200-pound reabsorber residue.

Two 50,000-pound-per-hour boilers were installed, which operate in conjunction with the original three 30,000-pound-per-hour boilers. These boilers operate at 300 pounds with 100° superheat. These boilers were installed in line with the original boilers, but due to their design, the new boilers were located out-doors, with the boiler fronts and control panels housed in an addition to the existing boiler house. The boilers use induced draft with turbines to operate the blowers.

Three steam systems are used in the plant; one at 300 pounds, one at 125 pounds and one at 15 pounds. The 300-pound steam system is used for agitation in the high-pressure stills and for operating the turbine-driven pumps. The turbines which drive the high-duty oil pumps, generators and the refrigeration unit operate condensing; and this water is pumped direct to the boiler feed water tank. The steam from the small turbines exhaust into the 125-pound steam system. Part of this steam is used in the reboilers of all of the fractionating equipment except the butane splitter. This condensed water from the reboilers passes through an exchanger, is mixed with other condensate and returned to the boiler feed tank. The remainder of the 125-pound steam is used to operate reciprocating pumps and for agitation in the low-pressure stills. These pumps, as well as the recompressors, exhaust the steam into the 15-pound system. Part of this steam is used in the reboiler of the butane splitter and the remainder is condensed and run to a sump. All of this dirty condensed steam passes through a permutit unit where the oil is removed and the clarified water is pumped to the boiler feed tank.

One new water well was drilled to provide for the increased water requirements. Three wells are now in use in the plant, one being for stand-by. Although the water is soft, it is high in alkalinity and contains a small amount of iron. All of the water from the wells is treated in a Birm unit for removal of the iron. Raw water make-up to the boilers is further treated to remove carbon dioxide and oxygen and then passed through an evaporator. Some treatment of the water is required in the cooling tower, the principal one being chlorination for algae control.

Electrical power is generated with two 750 kw., 3600 rpm. generator units operated by multi-stage condensing turbines. The power is three phase, 60 cycle, 480 volts. As the electrical load on the new plant slightly exceeded the original capacity of the generators, capacitators were installed, which raised the power factor from .80 to .95. One generator is used as a stand-by.

Steam turbines and electric motors are used to drive the centrifugal pumps. In order to balance the three steam systems properly, steam turbines are used on part of the pumps. The remaining centrifugal pumps are operated with motors.

In order to provide additional storage for propane, four new 1000-barrel propane tanks were installed, which gives a total capacity of 7350 barrels of propane. As storage facilities for the other products are adequate, no additional tanks were installed. The total storage capacity is approximately 179,000 barrels.

Fire System

Fire hydrants are located strategically throughout the plant yard. Water for the fire system is furnished by two centrifugal pumps capable of handling 240 gpm. each at 125 pounds discharge pressure. One pump is driven by a motor and the other pump is driven by a gas engine. A reciprocating pump is also connected to the fire system for emergency service. The fire system is maintained at 75 pounds pressure at all times through a connection from the plant yard system.

The plant is designed to handle 210,000 mcf of gas per day at 1050 pounds, recovering 60 percent of the propane and substantially all of the heavier hydrocarbons. This results in a total production of 7000 barrels. The gas handling equipment is designed to process an additional volume of gas at a reduced percent of propane recovery.

The unusual design of the new plant, using refrigeration and low molecular weight oil with resultant decrease in oil circulation rate, has reduced the investment 50 percent under that required for a conventional plant of the same capacity and recovery.

The new plant was designed and constructed by The Fish Engineering Corporation, Houston, under inspection and approval of engineers of The Chicago Corporation.

American Capital Helps to Build Refinery in Spain

Top photo is view of Cartagena refinery, village and partly-completed tankage prior to erection of processing units.

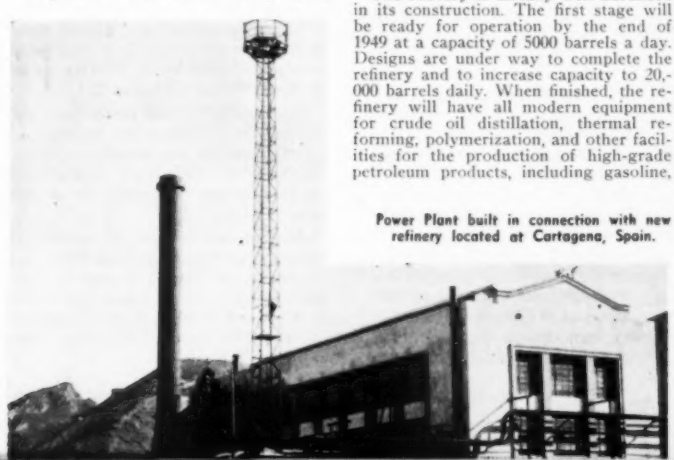
Lower photo shows gasoline and kerosine product tanks with walls and sand embankments required by government regulations.

A SPANISH - AMERICAN oil company, in which Caltex Oil Products Company of New York, is a partner, has been formed in Spain for the completion and operation of a refinery at Cartagena. The new company is Escombreras Petroleum Refinery, S. A., of which Caltex holds 24 percent of the capital investment. The balance of the investment is held by Spanish interests—52 percent by the National Institute of Industry and 24 percent by the Spanish Petroleum Company, S. A.

Capital of the new company totals 325 million pesetas ($29,835,000) which reportedly includes a loan by Caltex of $9 million. It is understood that the Spanish Government has guaranteed that Caltex will be able to take its share of the dividends out of Spain in the form of dollars.

The refinery is already well advanced in its construction. The first stage will be ready for operation by the end of 1949 at a capacity of 5000 barrels a day. Designs are under way to complete the refinery and to increase capacity to 20,000 barrels daily. When finished, the refinery will have all modern equipment for crude oil distillation, thermal reforming, polymerization, and other facilities for the production of high-grade petroleum products, including gasoline, kerosine, fuel oil, lubricants, paraffin wax and asphalt.

The refinery is the first major enterprise since the war between American and Spanish business interests. Caltex recently has been supplying nearly a third of Spain's oil requirements with crude shipped from the Persian Gulf and produced by Arabian American Oil Company, a subsidiary, like Caltex itself, of The Texas Company and Standard Oil Company of California. It is understood that Aramco quotas will supply all of the charging stock to the new Cartagena plant.



Power Plant built in connection with new refinery located at Cartagena, Spain.

First Entry Since 1928

This is the first entry of American oil concerns into Spain since 1928 when the then dictator, Prino de Rivera, seized foreign oil companies in Spain and established the Spanish Government petroleum monopoly CEPSA. This monopoly, created for 20 years, officially expired this year and its lapse leaves the way open for the re-entry of outside oil companies in Spain. The Cartagena refinery is strategically located and should play a large role in the projected industrialization program of Spain.

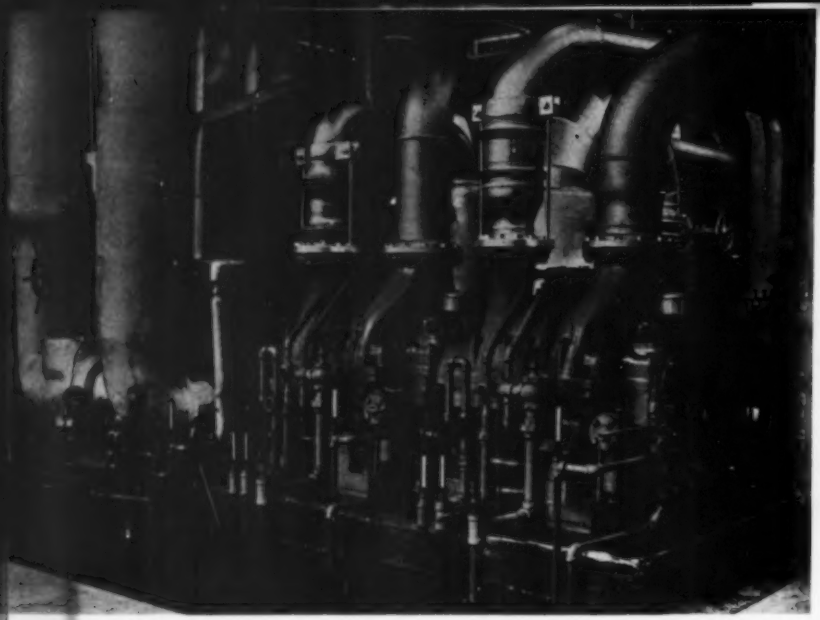


Figure 1

Application of Centrifugal And of Axial Compressors

T. R. FOSTER
Manager Turbo-Machinery Sales
Clark Bros. Co., Inc., Olean, N. Y.

CENTRIFUGAL gas and air compressors are being more widely used in American industry.

Centrifugal blowers have been used in the steel and manufactured gas industry for many years, and most engineers are familiar with these applications.

Newer is the relatively high pressure centrifugal compressor field from which we use commercial applications, either in operation or in process of manufacture as illustrations.

One of the simplest centrifugal applications in the compressor category is that for air operating between atmospheric intake pressure and at or around 100 psig. discharge pressure. While the 100-pound centrifugal air compressor has been widely applied for many years by European manufacturers in the various mining industries and a few installations were made in the past by American manufacturers, it appears that recent developments in tonnage oxygen plants, where centrifugal compressors have been almost exclusively used, may have rekindled dormant American interest in the 100-pound centrifugal air compressor.

***SOME PROCESS** engineers in refineries and gasoline plants have suggested that the centrifugal and axial compressors now coming into more widespread use bear roughly the same relation to reciprocating compressors that the modern centrifugal hot-oil pumps bear to the earlier crank-and-flywheel plunger-type hot-oil pumps. These men predict a similar pattern of events, too, in which continued development of the rotating machines will eventually result in their adoption for the bulk of process plant gas compression tasks. This present article, written by an expert in the application of turbo equipment and originally presented before the American Gas Association, reports the commercial possibilities of such machines at their present state of development. So far as the article goes, it seems to confirm the speculations of the plant engineers—who, after all, are not compressor designers even though they are quite expert in the utilization of such machines as are made available to them.*

Figure 1 shows a 7500-cfm., 9600-rpm, 1740 h.p. unit supplying 110 psig. general purpose compressed air at a Pacific Coast oil refinery. The unit is composed of two compressor cases coupled together with a through drive permitting the use of a single driver and standard type of air intercooler between cases. Four impellers in each case are employed. The diaphragms of these units are also arranged for intercooling and the upper and lower halves of the cases are provided with independent coolant connections to prevent any possibility of leakage at the horizontal split. There is one other identical unit operating on the Pacific Coast and a similar uncooled 6000-cfm., 1640-h.p. unit installed in an Atlantic Coast oil refinery. All three units are driven by direct connected steam turbines.

Five-electric motor, through speed increasing gears, 100-pound air compressors have been furnished to the European coal mining industry. One is driven by a 3500 h.p. wound rotor motor, three by 2500-h.p. wound rotor motors and one by a 1750-h.p. synchronous motor. **(Figure 2.)**

On tonnage oxygen production, the company is furnishing two 24,000-h.p., direct connected, steam turbine driven, 110,000-cfm, 3900-rpm., centrifugal air compressors delivering air at 108 psia.

Another application of centrifugal compressors that is gaining favor for a specific application is that of compressing propane used as a refrigerant in the M.E.K. solvent dewaxing process in the refining of lubricating oils. **(Figure 3.)**

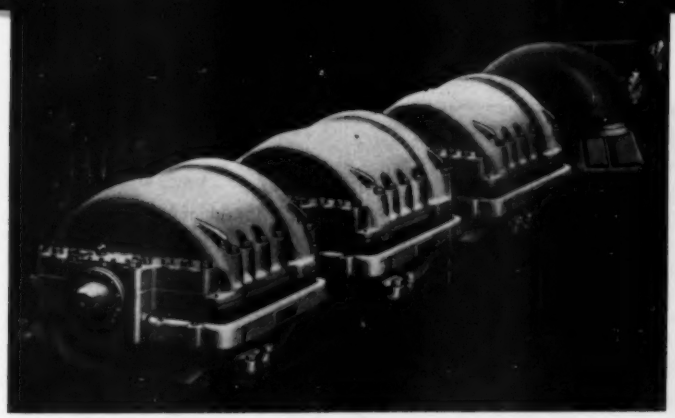


Figure 2

Figure 3

The unit shown is one of three units installed in a Gulf Coast oil refinery. It is driven by an 1870-h.p., 8500-rpm., direct-connected, steam turbine and operates between inlet conditions of 4200 cfm., —20° F., 26 psia. and a discharge pressure of 215 psia. Five impellers are employed in series to attain this 8.3 compression ratio with a conservative peripheral speed of 710 feet per second.

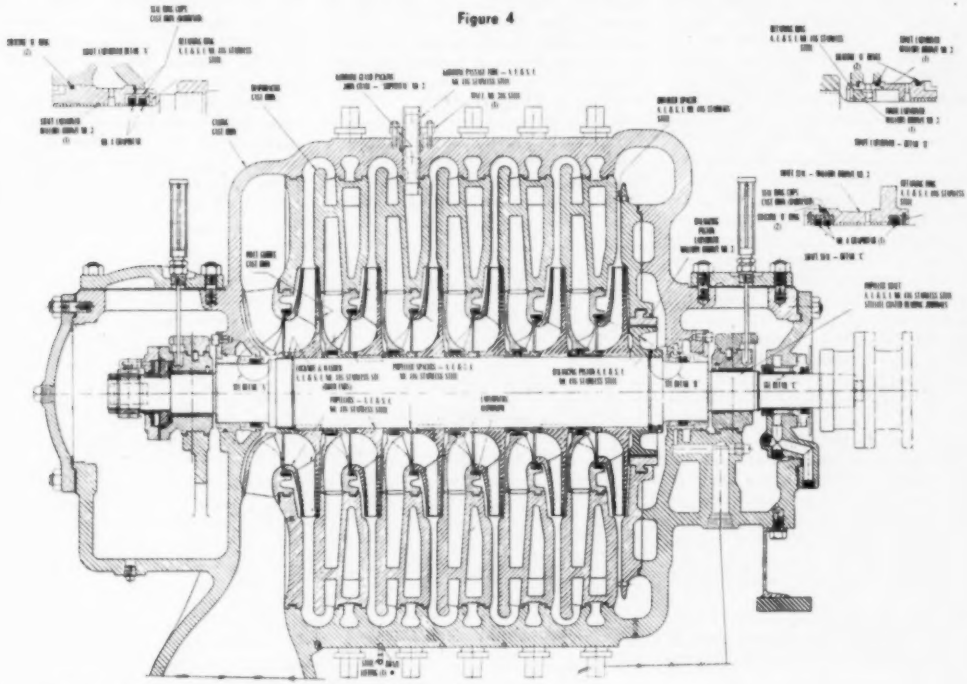
Five machines for this specific application are in operation. All are direct connected steam turbine driven, the smallest horsepower unit being 1020 and the largest 2700. Steam utilization varies from simple back pressure units exhausting to process, straight condensing units, and one extraction condensing unit with steam extraction varying between the limits of 10,000 to 75,000 pounds per hour. **(Figure 4.)**

The highest compression ratio machines, in one case, are represented by the illustrated six stage SO_2 compressor which will operate between 8.8 psia. and 102 pounds discharge. The 11.6 high compression ratio and the relatively high specific heat ratio of SO_2 necessitated the employment of diaphragm cooling to control the temperature differential across the units. Refrigerated kerosine at a temperature of 35° F. is used as the coolant.

Two of the four units being furnished for this duty are 100 percent spares. Direct connected steam turbine drivers of 960 h.p., 7850 rpm. were selected—one a simple back pressure unit and one straight condensing for each of the two streams. This was adjudged to be more economical, for this application, than the purchase of four extraction condensing turbines. **(Figure 5.)**

Lowest compression ratio units are those furnished for pipe line booster

Figure 4



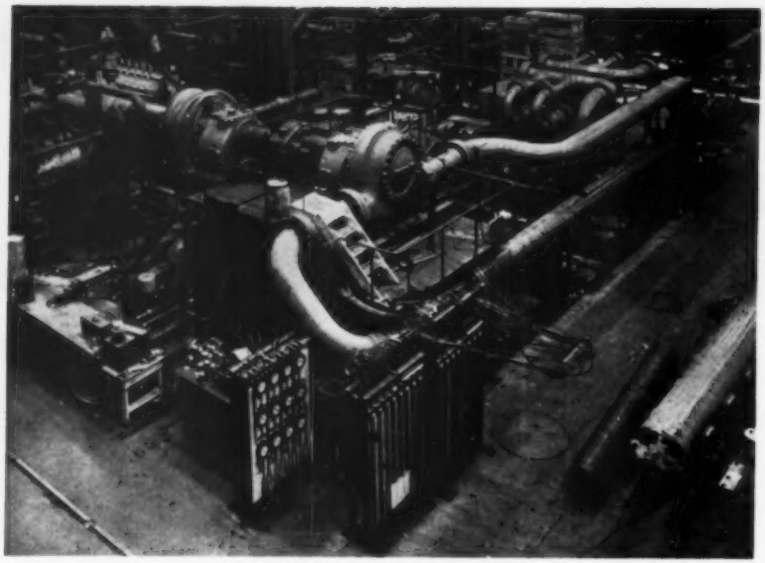


Figure 5

service where the existing motors fixed the speed of 3570 rpm. and the horsepower at 1250 with a resulting compression ratio of 1.08. The illustration covers a single stage 29-inch diameter pipe line booster, a number of which are in service up to 800 pounds discharge pressure. This unit is being given a shop test on a closed cycle that is suitable for pressures up to 1000 pounds. The gas coolers are arranged for alternate series or parallel flow testing. All pipe line booster units shipped, up to the present time, have been tested on atmospheric air, partial pressure on air, and full operating pressure on natural gas. **(Figure 6.)** The journal and thrust bearings, and the high-pressure seal were thus subjected before leaving the factory to operating conditions somewhat similar to those to be encountered in the field. The unit requires only one seal and has no wearing surfaces that could generate heat or restrict its usage on high rotative speed applications. The sealing is accomplished by means of a pressure oil film introduced in a conventionally babbitted solid sleeve type seal. Two double spherical ground and lapped joints allow the sleeve to follow the shaft and the only rotating element is the shaft itself which in turn operates on the oil film without surface contact. Only 2 gpm. of oil with a 2 h.p. motor is required for seal oil pumping with approximately ½ gpm. passing through the seal.

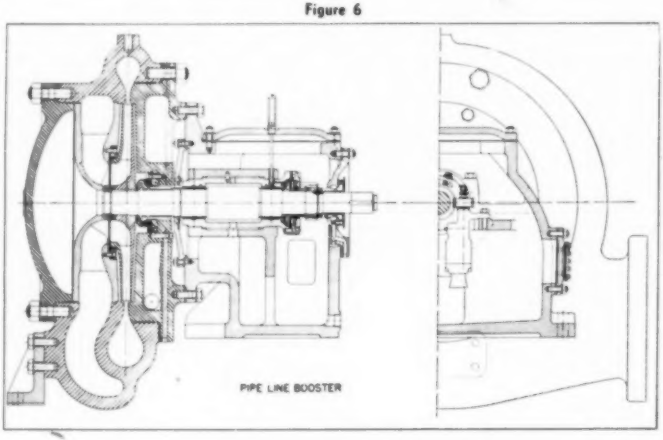
Similar single-stage units, if operated at commercial top speed with direct connected turbines or electric motor through speed increasing gear drives, will develop compression ratios in the range of 1.25 to 1.3 when handling natural gas on trunk pipe line applications. A maximum of two or three operating units in series with one identical spare is indicated at the present stage of acceptance. The valveless centrifugal is adapted to series rather than parallel operation for this duty. The hydraulic efficiency of the centrifugal is favored by compressing the whole stream rather than dividing it. **(Figure 10.)**

It will be noted that two impellers in series will provide 1.65-compression ratio when pumping natural gas on trunkline applications, approximately 29 horsepower per million standard cubic feet being required at the booster couplings. At 1.33-pressure ratio, the horsepower per million is approximately 15 while a compression ratio of 2 would require slightly over 41 bhp. per million and three impellers in series are indicated. These compression ratios are within the safe limits of radial shrouded type impeller peripherial speeds.

The highest pressure multi-stage machines will operate on low mol. weight mixed petroleum hydrocarbon and hydrogen gas. The inlet pressure is 300 pounds and the discharge pressure will be 450 pounds. At this elevated intake pressure an inlet volume of 4960 cfm. will be compressed by a four impeller, steel case, compressor operating at 8700 rpm. and direct driven by means of a 3800 h.p., 185 pounds back pressure steam turbine. Two such units are employed each of 50 percent total plant capacity. A multi-stage unit of smaller physical size has been designed for up to 800 pounds discharge pressure but the above 450-pound multi-stage machines are the highest pressure multi-stage units on order.

Recent developments in the jet aircraft field have focused attention of engineers on the axial flow type compressor. Many engineers want to know where this machine fits into the stationary air and gas compression field.

Figure 6



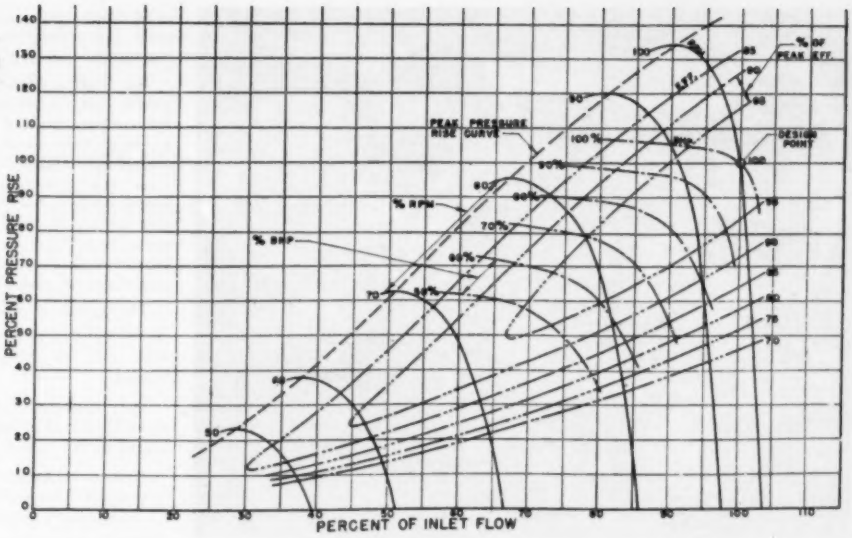


Figure 7. General Axial Flow Compressor Performance.

Future developments will undoubtedly modify any appraisal that may be made at this time. Neglecting the weight and space factors which are compelling arguments in aircraft or mobile power units but of less significance for stationary installations, where reliability and serviceability will govern, the most salient characteristics of the axial appear to be:

TABLE 1

Suction Volume CFM	ROTOR DIAMETER INCHES		SPEED RPM	
	Axial	Radial	Axial	Radial
20,000	17.5	32"	11,650	5500
60,000	30.3	42.5"	6,770	4150
100,000	39.0	42.5"*	5,250	4150*
150,000	48.0	....	4,270	....
200,000	55.0	....	3,720	....
300,000	67.5	....	3,040	....

* Double flow radial centrifugal compressors above 60,000 inlet CFM.

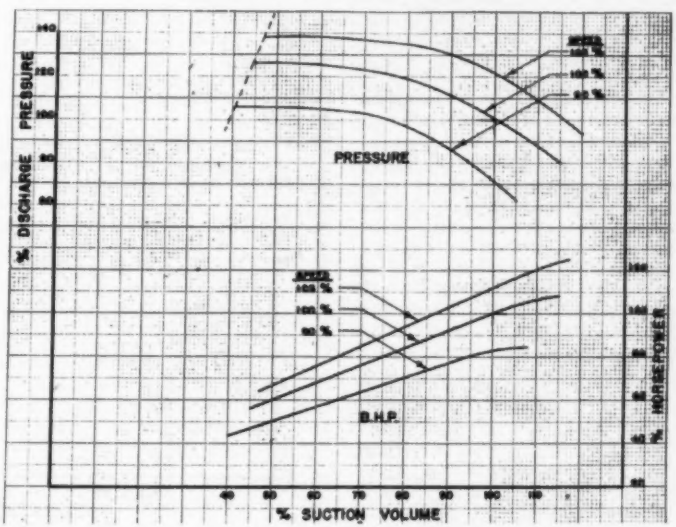
(1) High volume or conversely relatively high rotative speed for commonly encountered inlet volumes. The speed versus volume tabulation suggests the use of axials, other characteristic factors permitting, where the acquisition of an economical direct connected driver will be furthered by speeds in the 3600 to 4000-rpm. range, the commercial speeds of double flow radial centrifugal compressors having dropped to an uneconomical level. It is apparent that inlet volumes of 150,000 cfm. and above present commercial possibilities for axial application.

(2) A steep pressure volume characteristic in contrast to the relatively flat pressure volume characteristic of the radial type centrifugal. **(Figures 7 and 8.)** As illustrated, the axial is better adapted to fixed volume applications or where the volume varies over a narrow range and where a relatively wide range of pressure ratio or head is desirable. It may be observed that this characteristic is similar to that of the reciprocating type of compressor with one important distinction. The reciprocating compressor is adapted to the addition of clearance pockets thereby adding to its flexibility while no similar commercial characteristic modification has, to our knowledge, been developed for the axial.

The radial centrifugal is best adapted to handling wide variations in volume where the variation in head or pressure ratio is not of great magnitude. The variation in stable range of operation varies with compression ratio with pulsation or surge occurring at around 30 percent volume for 1.1 ratio and at approximately 70 percent volume for the 11 to 12-pressure ratio units. The stable range of the axial is likewise affected by compression ratio.

(3) A relatively high compression efficiency when handling large volumes and its adaptability to relatively

Figure 8. Centrifugal Compressor Performance.



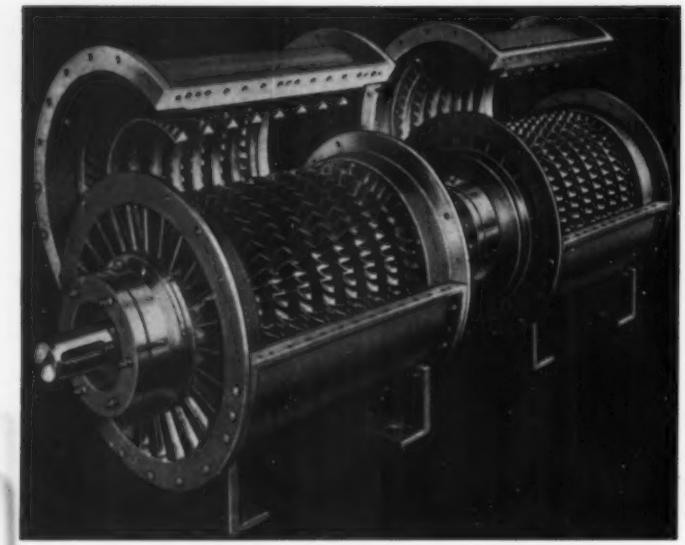


Figure 9

high discharge temperatures.

Engineers are familiar with the adaptations being made of the axial compressor to gas turbine cycles. On open cycles with capacities in the 3000 to 12,000 h.p. range the axial seems to be well adapted as regards capacity, approximately 12 cfm. per rated output horsepower being required on a relatively simple cycle with regeneration. (Table 1.) Thus a 5000-h.p. unit would require approximately 60,000 cfm. through the axial compressor and the rpm. of 6770 mates with the speed of a centrifugal booster for high capacity gas pipe line duty. The high efficiency of the axial contributes in no small measure to higher over-all efficiency in proposed pipe line gas turbine cycles. The axial does appear to have future commercial significance in this field. **(Figure 4.)**

The radial compressor is not as flexible as the axial with regard to discharge temperature because the diaphragms, or stage separation walls, have a tendency to expand with temperature to a larger degree than the outer shell thereby limiting the temperature rise across the machine. This limitation varies with design, an approximate figure being 350° F. resulting in a discharge temperature of 450° F. with 100° F. inlet temperature or 500° F. with 150° F. inlet temperature. As stated herein before the radial centrifugal compressor is sometimes provided with liquid cooling in the diaphragms to permit higher compression ratios, in a single case, while staying within safe limits of design. **(Figure 9.)**

The axial compressor has no such solid diaphragms extending across the shell. The consequences of growth and temperature stresses are not as acute.

The higher efficiency of the axial means that, in an uncooled machine, less temperature rise will take place in an axial than in an uncooled radial centrifugal compressor. This suggests some applications of relatively high volume axials for compression ratios just beyond the reach of an uncooled radial centrifugal. Because of its higher efficiency, the use of intercoolers can sometimes be avoided.

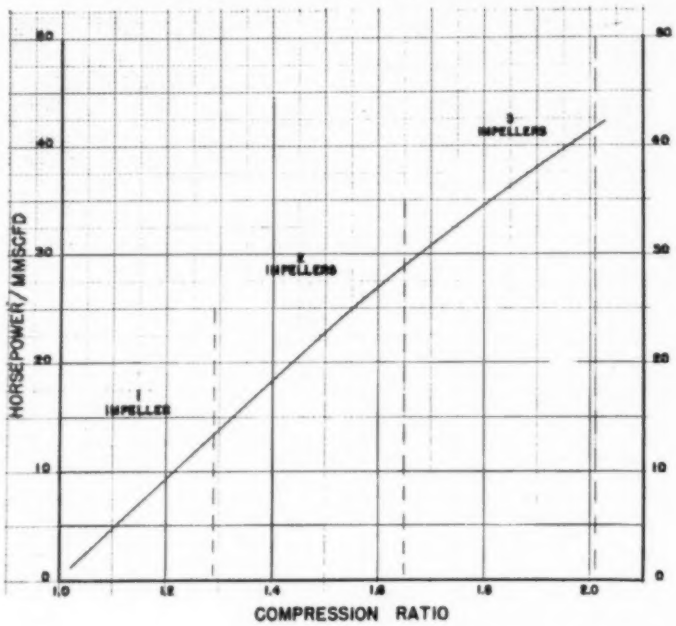
The above is predicated upon the characteristic of the axial being suitable for the compression duty involved.

It is apparent that the axial is not as well adapted to intercooling between stages as the radial centrifugal.

A stage in an axial is composed of one set of rotating blades and one set of stationary blades. A rough rule of thumb in comparing radial centrifugal stages with axial stages, for a given compression duty, is two stages in the axial to one stage in the radial. Peripheral speed in the axial is assumed as 900 feet per second as compared to 770 feet per second in the radial shouded impeller centrifugal.

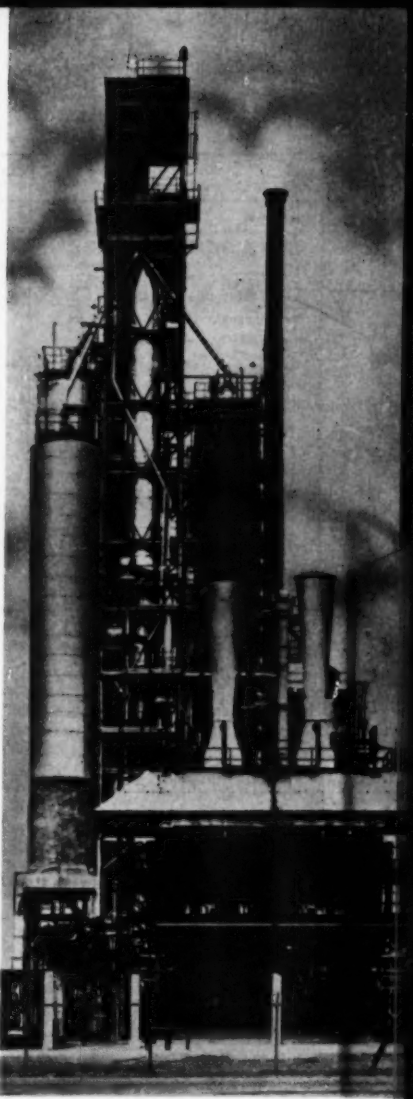
Figure 10

Variation of Horsepower with Compression Ratio, Centrifugal Gas Compression. Natural Gas: S.G. = 0.6; $C_P/C_V = 1.27$ $T_1 = 60°$ F. $P_D = 750$ psig.



Initial Operation of Continental's Catalytic Cracker

J. E. FENEX, A. W. HOGE and LEE FRIEDMAN



CONTINENTAL Oil Company's fourth TCC unit, one of the latest of the small scale moving bed catalytic cracking units, and located just outside of Denver, Colo., went onstream on November 19, 1948.

Originally the refinery consisted of a 3500-barrels-daily topping unit, a conventional two-coil thermal cracking unit and a small liquefied petroleum gas plant. The enlarged refinery can process approximately 7500 barrels crude oil daily. The expansion also includes a new vapor recovery and gasoline stabilization unit, catalytic polymerization and enlarged LPG facilities. In addition the existing 1500 barrels daily thermal unit has been revised to thermally reform virgin naphtha and to process TCC unit tar and cycle stocks instead of straight run gas oils.

The marketing situation in the Rocky Mountain area is characterized by weak heavy fuel oil and demand and the need for a maximum gasoline yield. Thermofor catalytic cracking, with the highest designed internal recycle ratio to date for such units, was selected as the optimum means of obtaining the desired refinery product distribution. After a 15-day demonstration run (December 26, 1948, to January 10, 1949), the TCC unit was accepted as having exceeded its guaranteed performance. The unit has since continued its excellent record and to play its part in maintaining the optimum economic refinery product balance.

THE TCC UNIT which Continental Oil Company installed at its refinery located just outside of Denver's city limits is an important portion of the plant's expansion program completed last year. This expansion not only doubled the crude processing capacity of the Denver refinery, but also has resulted in substantial improvement of the quality of the finished gasolines.

The tightly integrated nature of operation is termed the most outstanding feature of the Denver plant. The charge to each unit is received directly from the preceding section of the refinery without any intermediate storage. Another feature is the use of the common control room for all process units.

Mr. Fenex is stationed at Denver with Conoco while the other two authors are connected with Houdry Process Corporation, Philadelphia.

Process Description

On the initial start-up, the expanded refinery processed approximately 7500 barrels daily of a blend of Lance Creek and Horse Creek, Wyoming low sulphur crude oils. On January 20, sour Rangely crude oil was brought in and made up most of the charge to the crude unit. A true boiling point evaluation of the three crude oils is summarized in Table 1. The Lance Creek crude oil is the very highly paraffinic material; the reduced crude has an aniline point of approximately 204° F. and is the stock upon which the performance guarantees were based. Table 1 indicates that the F-2 clear octane number of the 300° e.p. gasoline is 54 while the F-2 rating of the 300-410° F. gasoline fraction calculates 10. The approximately equivalent fractions of the Horse Creek crude oil have octane values of 72.0 and 44.5, indicating a much lower paraffinicity of this stock. The moderately sour Rangely crude oil (0.87 weight percent sulfur) is intermediate in paraffinicity between the two Wyoming crude oils.

An unusual processing feature in the refinery is the recycle ratio of the TCC unit reactor. In order to obtain the maximum gasoline yield and a minimum fuel oil production, the reactor has been designed to operate at a recycle ratio of 1:1 on a fresh reactor charge of 3300 barrels daily. For a short time the TCC operation approached total recycle when both of the catalytic gas oil streams, light catalytic gas oil and the heavier recycle stock were returned to the reactor.

The refinery crude oil charge is processed in a conventional manner in the crude distillation unit. Approximately 30 percent of the 365° F. e.p. straight-run gasoline and lesser quantities of the distillate fuels are removed from the crude, leaving approximately 49 percent reduced crude as charge to the TCC unit. The topped

TABLE 1

TBP Evaluations, Denver Refinery Crude Oils

	Horse Creek Crude Oil	Lance Creek Crude Oil	Rangely Crude Oil
Crude Data			
Gravity, °API @ 60°F.	34.6	42.4	34.6
Viscosity, CS @ 100°F.	9.21	3.09	5.77
Pour Point, °F.	+60	+4.5	—10
Color	Red-Brown	Dark Green	Green-Brown
RVP		4.1	4.4
Sulphur, Wt. %	0.24	0.26	0.87
Rams. Carbon Residue, Wt. %	1.41	0.83	2.38
NaCl, gm/bbl.	16	0.5	0.0
Crude Break-Up, % on Crude			
% C₅ and Lighter	2.5	—	1.48
Gasoline Fractions, °F.	IBP-290 290-391	IBP-300 300-410	IBP-272 272-395
% on Crude	14 10	29 15	14 14
°API	68.8 47.5	65.1 48.4	70.0 50.6
Sulphur, Wt. %	.008 .009	.008 .022	.003 .023
F-2 Octane, Clear	72.0 44.5	54 10	61 35
Distillate Cut, °F.	391-596	410-579	395-604
% On Crude	24	21	28
°API	37.1	39.7	35.7
Viscosity, SSU @ 100°F.	36.3	37	35.7
Sulphur, Wt. %	0.15	0.033	0.53
Cold Test	—5	+7	—25
Heavier Fractions	Resid.	Gas Oil Resid.	Resid.
% On Crude	46.0	15.0 20.0	44.0
°API	23.6	33.6 23.5	21.0
Sulphur, Wt. %	0.47	.24	1.42
Vis., SSU (G.O.) @ 100°F. (Resid.) @ 210°F.	81.6	68 110	77
Carbon Residue, Wt. %	3.14		

crude varied in gravity from 24° API to 27° API depending on the quantity of diesel oil withdrawn from the crude tower. The TCC charge stock has never included material in the gasoline boiling range.

A vacuum assay of the TCC reduced crude charge when the refinery charge consisted of a blend of 85 percent Lance Creek and 15 percent Horse Creek oil was as follows:

	Corrected to 760 mm. Pressure
I.B.P.	545° F.
10 Percent	635° F.
20 Percent	662° F.
30 Percent	708° F.
40 Percent	756° F.
50 Percent	807° F.
60 Percent	863° F.
70 Percent	930° F.
80 Percent	962° F.
87 Percent	980° F.
°API	26.6°
Carbon Residue	2.64 Weight Percent

The topped crude is charged directly to the TCC heater at a temperature of 545° F. from the bottom of the secondary crude distillation tower. The heater effluent at approximately 855° F. flows to a tar separator where, under the condition of the demonstration run, 12 percent of the 51 percent reduced crude was removed as tar. The remainder of the fresh charge is taken overhead in the tar separator as virgin reactor charge. The relatively large quantity of recycle catalytic gas oil decreases to some extent the quantity of steam required to aid in the vaporization of the fresh charge in the tar separator. The vaporization steam is added to the oil in the final rows of tubes in the heater, superheating the steam to the same temperature as that of the oil. A small quantity of low pressure steam is introduced into the top of the tar separator to prevent hydrocarbon condensation in the overhead line to the reactor.

TABLE 2

Test Run Yield Summary and Operating Conditions, Denver Plant

	Guarantee B/D	Average During 15-Day Test Run B/D	# /Hr.	Vol. %	Wt. %
Charge					
Reduced Crude	3300 Min.	3790	48,848		
Recycle Gas Oil		3814	48,940		
Total Charge to Tar Separator		7604	97,488		
Tar Product		466	6,350		
Total Reactor Charge		7148	91,129		
Virgin Reactor Charge	3300 Max.	3342	42,289	100.0	100.0
Products					
C_1 and Lighter			750		1.8
C_2's			786		1.9
C_3's		334	2,487	10.0	5.9
C_4's	433 Min.	576	4,890	17.2	11.6
Debutanized Gasoline	1981 Min.	2152	23,233	64.4	54.8
Light Cat. Gas Oil		451	5,745	13.5	13.6
Syn. Tower Bottoms		134	1,924	4.0	4.5
Liquid Recovery, C_4+	3121 Min.	3313		99.1	
Carbon (On Catalyst Analysis)			2,860		6.8
Gain			+386		+0.9
Conversion, Vol. %			82.5		
Cracking Efficiency, Vol. %			78.2		
Operating Conditions					
Space Rate: Total Feed			1.29		
Space Rate: Fresh Feed			0.59		
Space Rate: Recycle			0.70		
Catalyst/Oil Ratio, T.F.			2.00		
Oil to Reactor, °F.			843		
Catalyst to Reactor, °F.			884		
Avg. Catalyst Temp. in Reactor, °F.			876		
Steam, Wt. % Total Feed			3.84		
Reactor Top Pressure, PSIG			7.7		
Catalyst Circ., T/Hr.			78		
Carbon on Spent Catalyst, Wt. %			2.10		
Carbon on Reg. Catalyst, Wt. %			0.22		
Kiln Steam Prod. #/Hr.			23,880		

The effluent from the TCC reactor at about 875° F. is fractionated in the synthetic crude tower to produce a wet gas stream, light and heavy gasoline, light catalytic gas oil, and intermediate catalytic gas oil for internal recycling and heavy catalytic gas oil (synthetic tower bottoms). The TCC wet gas is compressed to 200 psig., contacted with a light gasoline with the combined streams entering the bottom of the gas plant absorber.

Absorber operation permits the C_2's and lighter to pass overhead as fuel gas and delivers a C_3+ bottoms stream to the stabilizer for the production of debutanized 400° F. e.p. gasoline. The stabilizer overhead is totally condensed and charged directly to the Girbotol treater for sweetening. Girbotol effluent flows directly to the catalytic polymerization unit for further gasoline production.

The light and heavy catalytic gas oil product, along with the tar separator bottoms, are charged directly to the thermal unit and heavy gas oil tower for thermal cracking and vis-breaking. The thermal unit recycles the light gas oil to extinction, increasing the refinery gasoline yield and completely eliminating cracked distillate production.

The catalytic polymerization reactor effluent is fractionated in the LPG plant through a deethanizer, depropa-

TABLE 3

Stream Inspections, ASTM Distillations

	Reduced Crude	Recycle Gas Oil	Furnace Charge*	Tar	TSO	Light Gasoline	Heavy Gasoline	Debut. Gasoline	Lt. Cat. Gas Oil	Syn. Tr. Bottoms
°API	29.4	29.5	28.8	16.4	30.5	60.6	36.0	59.4	30.1	11.9
RVP						7.3		5.2		
ASTM, °F.										
IBP	505	420	440		440	101	246	107	412	521
10%		520			536	140	341	130	440	619
20%		530			547	165	349	143	448	662
50%		560			594	221	370	209	462	
90%		650				310	411	354	494	
E.P.		700			700	364	444	410	536	700
Rec. %		98			85	98	99	99	99	36
Clear Octane Numbers										
F_2								77.8**		
F_1								87.8		

*Approximately 525 B D of Tar Recycled to Heater.

**F-2 Octane Number for 10 # RVP TCC Gasoline = 78.7.

Guaranteed F-2 Octane Number for 10 # RVP TCC Gasoline = 78.0.

nizer, and debutanizer, in that order. Propane and butane are taken overhead of their respective columns, dried through flake caustic, and flow to LPG storage. The deethanizer overhead, along with the TCC absorber overhead, supplies the refinery fuel gas system.

Description of Mechanical Features

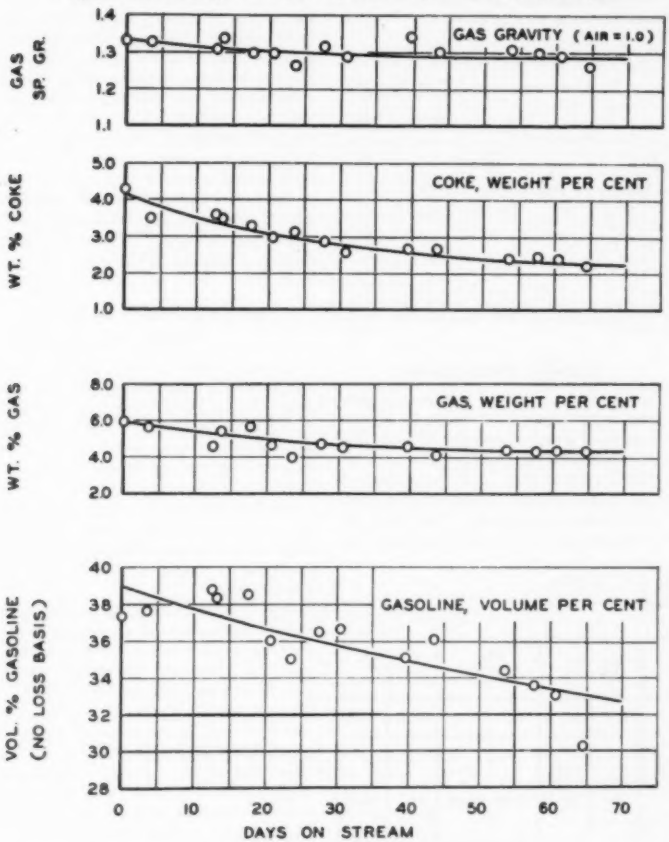
Perhaps the most outstanding feature of this refinery is the tightly integrated nature of the plant operations. The charge to each unit is received directly from the preceding section of the refinery without any intermediate storage. Except for some gas oil storage for thermal unit charge, no intermediate surge capacity has been provided within the refinery. As an example, the TCC heater was designed to receive hot reduced crude directly from the bottom of the secondary crude tower. Another simplifying feature of the refinery is the use of the common control room for all the process units. The existing control room was revamped to include the control instrumentation for the new and enlarged refinery units.

The TCC charge material is processed through the conventional arrangement of heater, tar separator, reactor-kiln section and distillation section. The unit includes a single split-bucket type elevator for circulation of both the spent and regenerated clay catalyst. In addition, the elevator mechanisms, including the cylindrical housing, is suspended from the top of the TCC structure. The TCC unit itself has a very compact arrangement, the kiln, reactor, synthetic crude tower, stripper tower and tar separator are in the same vertical plane and all can be reached from the same common level on the TCC structure. The unit, as well as the rest of the refinery, has a striking appearance because of the bright aluminum sheet used to wrap the insulation on both the vessels and the lines.

The TCC unit was originally designed to process sweet stocks only and, except for some alloy steel required by temperature limitations in the kiln, carbon steel was specified throughout the unit. On the same basis, no catalyst prehydration facilities were required to protect the natural clay catalyst from sulfur poisoning. However, while the plant was under construction, the refinery charge stock picture changed to include the moderately sour crude oil (0.87 weight percent sulfur) from the Rangely, Colorado, field. For corrosion protection against the high-sulfur stocks, alloy liners were added in critical locations. Chrome (11-13 percent) steel liners were installed in the tar separator and the bottom section of the synthetic crude tower; an 18-8 chrome-nickel alloy lining was added to the reactor.

The introduction of the sour stocks also made it desirable to install steam hydration facilities to alleviate abnormal aging of the catalyst. Steam distribution spiders were added to the reactor hopper and the bottom of the kiln just above the first draw-off tray. The effectiveness of the hydration steam is indicated by the normal aging of the catalyst even when processing sour stocks. The TCC reactor was switched from flue gas seal to steam seal just prior to the introduction of

Figure 1. Cat-A Catalyst Activity vs. Days on Stream, Filtrol TCC Clay Catalyst.



Unloading Fresh Catalyst by Means of Conveyor Belt from Freight Car to Storage Bin.

TABLE 4
Stream Inspections POD Analyses

	Absorber O.H. Mol.%	Debutanizer O.H. Mol.%	Debutanized Gasoline Liq. Vol.%
H_2*	38.6		
C_1	40.4		
C_2 =	5.4	1.1	
C_2	11.7	3.0	
C_3 =	3.0	20.3	
C_3	1.4	12.7	
C_4 =		28.1	
iC_4	0.3	27.3	0.09
nC_4		8.0	
C_5+	1.2	1.5	99.91
	100.0	100.0	100.00

*Hydrogen content assumed to be 47.5% of C_1 Fraction.

the Rangely crude oil to the refinery. The initial hydration conditions were as follows:

Hydration Steam to a) Bottom of Kiln	= 1,974 lb./hr.
b) Reactor Hopper	= 2,566 lb./hr.
Total	4,540 lb./hr.
Steam to Reactor Seal	= 588 lb./hr.
Reactor Seal Differential	= 10" of water
Reactor Catalyst Circulation	= 74 tons/hr.
Reactor Top Pressure	= 6.1 psig.

The changeover occurred without incident and the unit has continued to operate smoothly.

A mechanical feature of interest in the refinery is the compressor installation in the gas plant. TCC wet gas, as well as straight-run and thermal unit stabilizer gases, are compressed through a 1000-horsepower, two-stage reciprocating compressor driven by a 3600-rpm. steam turbine through reduction gears. There are two such units, each of which is designed to handle the total charge to the gas plant. The turbine drive was installed with the possible future replacement by an electric motor drive in mind.

Test Run Summary

The performance of the new TCC unit was thoroughly evaluated in a 15-day demonstration run. The charge to the TCC unit during this period consisted of Lance Creek reduced crude with a small percentage of Horse Creek reduced crude. The yields and operating conditions during the test period are summarized in Table 2. Typical stream inspections during this same period are indicated in Table 3 (ASTM Distillations and Octane Values) on Table 4 (Pod Analysis). Note that the recycle ratio of 1:1 to 1 has raised debutanized gasoline production to a high level despite the paraffinicity of the charge stock. The 64.4 volume percent yield of debutanized gasoline based on fresh feed and its 10 pound Rvp. F-2 clear octane number of 78.7 are both in excess of the guaranteed performance. TCC gasoline production increased to approximately 2306 barrels daily upon blending with LPG butane to 10 pounds Rvp. It will also be observed that a C_4+ liquid recovery of 99.1 volume percent was obtained even at this high conversion level of 82.5 volume percent. The increase in refinery gasoline production through catalytic polymerization of the C_3 and C_4 unsaturates in the TCC reactor effluent is summarized in Table 5. These data indicate that catalytic polymerization increased in the C_5+ gasoline production to 73.4 volume percent of the TCC virgin reactor charge.

The over-all product yields for both catalytic cracking and catalytic polymerization are as follows:

	B/D	Lbs./Hr.	Percent Virgin Feed to TCC Reactor: Volume Percent	Weight Percent
C_1's	....	750	....	1.8
C_2's	....	786	....	1.9
C_3's	129	963	3.9	2.2
Excess C_3's	165	1,385	4.9	3.3
10lb. RVP Gasoline	2,650	28,000	79.3	66.1
Light Cycle Stock	451	5,474	13.5	13.6
Heavy Cycle Stock	134	1,924	4.0	4.6
Carbon	....	2,860	....	6.8
				100.4

C_4+liquid recovery = 101.7 volume percent of TCC virgin feed.

Catalyst Performance

The TCC unit used Filtrol clay catalyst with a normal inventory in the system of approximately 268 tons. The two hot catalyst storage bins of combined capacity of 278 tons make it possible to empty the circulating catalyst system completely. The Cat-A activity of the initial catalyst charge was approximately 39 and after 60 days on stream had decreased in a normal manner to an activity of approximately 33. Figure 1 is the catalyst aging record for the first two months of operation of the new unit. Figure 2 indicates catalyst usage and the average particle size of the circulating catalyst over the same period. The excellent average particle size of 0.15 inches indicates efficient elutriation and a minimum of catalyst attrition. During the test period, the carbon content of the spent catalyst remained fairly constant at 2.10 weight percent while that of the regenerated catalyst was 0.22 weight percent. The carbon burn-off, based on catalyst analysis, was 2860 pounds per hour when the kiln 175-psi. steam production averaged 23,880 pounds per hour.

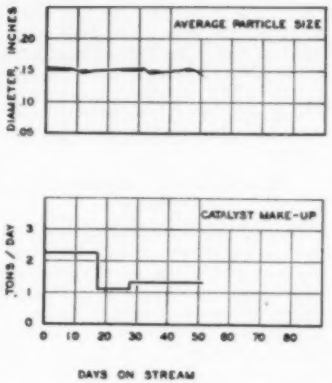


Figure 2. Catalyst Size and Makeup vs. Days on Stream.

TCC Gasoline Finishing Treatments

Treating the catalytically cracked gasoline for the production of the doctor-sweet, stable and non-corrosive fuel has proved to be a simple matter. A single-stage treat with strong-batch caustic and the use of the proper inhibitor are the only additional refining steps necessary to produce specification gasoline. Such was the case even when the sour Rangely crude oil made up a major portion of the refinery charge.

The original refinery design provided a commercial sweetening unit for the production of a doctor-sweet gasoline. The use of strong caustic (30-35 weight percent NaOH) in a 50-50 volumetric mix with the gasoline has obviated the necessity of using the sweetening unit. The TCC gasoline thus treated was usually slightly sour to the doctor test on leaving the caustic wash drum but became doctor-sweet in storage in a short time.

TABLE 5
Total Catalytic Gasoline Production

	TCC Effluent		Cat. Poly. Feed		Cat. Poly. Effluent		Total Catalytic Gasoline		% of TCC Virgin Reactor Charge	
	B/D	#/Hr.	B/D	#/Hr.	B/D	#/Hr.	B/D	#/Hr.	Vol.%	Wt.%
C_1's		750		6		6				
C_2's		786		282		189				
C_3's	334	2,487	305	2,274	119	899				
C_4's	576	4,890	567	4,772	356	2,990				
C_5 + Gasoline	2,152	23,233			307	3,250	2,459	26,483	73.4	62.3
Light Catalytic Gas Oil	415	5,745								
Heavy Catalytic Gas Oil	134	1,924								

Test for Automotive Gear Lubricants

RECENT investigations at the National Bureau of Standards by S. A. McKee, J. F. Swindells, H. S. White and Wayne Mountjoy have shown that the SAE extreme-pressure lubricants testing machine can be adapted to measure accurately the wear obtained with various automotive gear lubricants under simulated service conditions.[1] This apparatus, orginninally designed for testing load-carrying capacity of gear lubricants under fixed high-speed and shock-loading, provides a sensitive means for the evaluation of lubricants with respect to wear at high torque and low-speed operation. The new test therefore makes it possible to detect any significant difference in the performance of lubricants meeting the requirements of the same specifications.

Lubricants used in the Bureau's investigation were SAE 90 grade and included a Navy contract 1080 mineral oil, five lubricants conforming to U. S. Army Specification 2-105B,[2] five lubricants conforming to Federal Specification VV-L-761,[3] and one lead-soap active-sulfur lubricant.

In these wear tests, the upper cup is driven at a speed of 500 rpm. with a 3.4-to-1 gear ratio between the upper and lower cups, thus providing a 2.4-to-1 ratio of rubbing to rolling at the contacting surfaces. The specimens, steel Timken test cups (T-48651), have an average (root mean square) surface roughness of from 25 to 30 microinches as measured with the Profilometer. Each lubricant sample (two quarts) is circulated at a rate of about 500 grams per minute. With a constant oil temperature of 225° F., tests were made at constant loads of 90, 135, 180, and 225 pounds (scale readings). The loading system is such that the corresponding loads on the 2-inch diameter by ½ inch test cups are ten times the scale readings. Tests were also made at 250° F. and 180 pound load. These conditions approximate the range of conditions in the usual high-torque low-speed gear tests.

The test cups are weighed before and after each period of operation, the loss in weight being used as a measure of wear during the test period. It was found that representative data could be obtained by operating for about 25 hours, with weighings after 4, 11, 18, and 25 hours operations.

In general, the data obtained indicate that there is a run-in period of high rate of wear for a few hours, after which the wear settles down to a fairly constant rate. In a graphic plot of such data the straight portion of the curve usually is well established by 25 hours of operation. The slope of this portion of the curve is more significant from the standpoint of estimating gear life than the observed loss in weight for any given length of time.

Although wear data with hypoid gears are not available for a direct comparison, it is believed that these results are in reasonable agreement with the known service performance with these lubricants. The wear with the mineral oil was low up to the point where it would not carry the load, while with the lead-soap active-sulfur lubricant (which will carry a high shock load) the wear was high at all but the lightest.

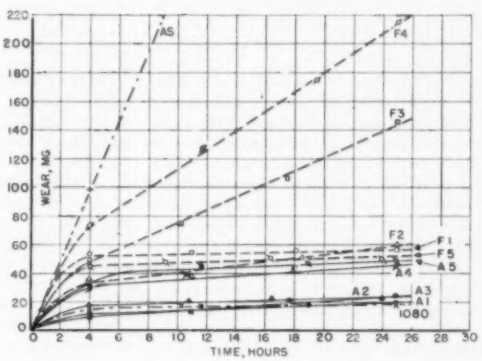
In connection with a brief study of the effect of the original surface roughness of the cups on the rate of wear, test data were obtained with the mineral oil and one of the Army specification lubricants operating at 225° F. and 135-pound load, using cups with original roughnesses of 14, 28, and 35 microinches (rms). Such operations brought the roughness of the cups fairly close together. While the run-in wear tended to increase with increase in roughness, the final rate of wear was practically independent of the original surface roughness over the range covered.

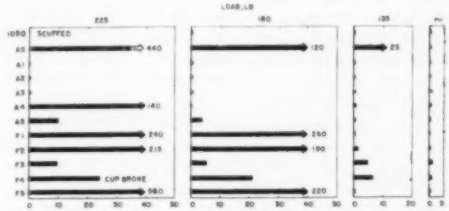
Lubricants containing the more chemically active additives for withstanding higher shock load tend to show the greater wear. This is in agreement with the known service performance of some of these lubricants, particularly the active-sulfur lubricant and the nonadditive mineral oil.

Figure 1. The SAE Extreme-Pressure Lubricants Testing Machine, as modified by the National Bureau of Standards, for wear test with automotive gear lubricants. By means of a special oil-circulating system, oil from reservoir A is drawn through pipe C to upper test cup which is covered by splash guard D. The oil then drains to box E, hence through overflow pipes F into the drain pipe G and back to the reservoir. Heaters are located at J and K and themocouples at H.

Figure 2 (Top). Wear vs. time curves for all lubricants (SAE 90) operating at 135-lb. load and 225° F. Only three of the lubricants show appreciable wear after the run-in period. Lead-soap active-sulfur lubricants, AS; Army specification (2-105B) lubricants, AS; Federal specification (VV-L-761) lubricants, F; Mineral oil, 1080.

Figure 3 (Bottom). Bar graphs of the rate of wear (after run-in period) for all lubricants (SAE 90) at 225° F. Mineral oil, 1080; lead-soap active-sulfur lubricants, AS; Army specification (2-105B) lubricants, A; Federal specification (VV-L-761) lubricants, F.





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[1] For further technical details see "Laboratory Wear Tests with Automotive Gear Lubricants" by Samuel A. McKee, James F. Swindells, Hobart S. White, and Wayne Mountjoy, J. of Res. NBS 42, 125 (RP1955) 1949.

[2] U. S. Army Specification No. 2-105B, Lubricant, Gear, Universal (Mar. 28, 1946).

[3] Federal Specification VV-L-761 for Lubricants, Enclosed-gear, Hypoid-gear and other types (Nov. 28, 1947).

Mechanical Design of a Refinery Process Unit

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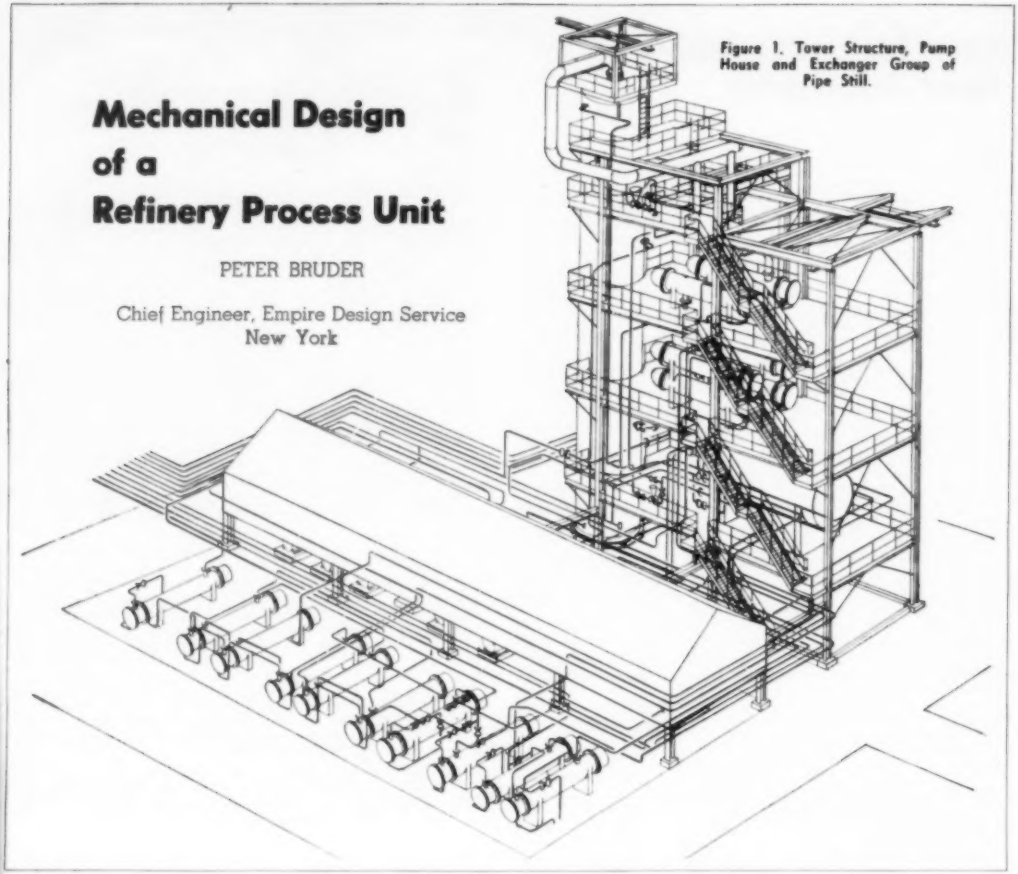

Figure 1. Tower Structure, Pump House and Exchanger Group of Pipe Still.

SINCE the early part of World War II, the demand for gasoline and oil has been enormous. In the years 1940-1945 a great number of oil refinery process units have been built. Due to haste and a poor labor market, some of these units were not too well designed with regard to facility of operation and "eye appeal."

The postwar era demands better planning. In the intervening years engineers and designers have accumulated sufficient data as a result of their war plant experiences to be able to visualize and execute greatly improved mechanical arrangements and facilities for process units. Scarcity of materials, new operational recommendations, and accumulated engineering experience have introduced new factors in plant designs. The scope of this article, then, is to present some of the changes that have occurred and to suggest methods for the better design of pipe stills.

Prerequisite to Piping Designs

The place for a better layout starts in the drafting room. The job is first introduced in the form of flow charts, location and size of plot with the surrounding conditions noted, and a copy of the standards and specifications for the job. An initial task is to confer with the customer and, with the information thus obtained, arrive at a proposed general arrangement of the unit. At such conferences it is the duty of the designer to make suggestions and recommendations with respect to piping for the location of the equipment. The designer's presence at early conferences between job engineer and customer's engineer is also extremely useful in absorbing the customer's suggestions, points of view, decisions formed, etc., to better understand what will be expected in the designs to follow.

On the basis of such conferences and studies, the general arrangement or "proposed plot plan" is completed by the design staff. The units are arranged but the relationship between them on this plan is not necessarily fixed as piping runs may subsequently prove too long for economy or on the other hand too short to take care of flexibility, interferences with foundations, and so on. The preliminary layout is submitted to the customer for further consideration and comments. Only after receiving his comments can final design work be started.

After the receipt of customer comments, the plan is revised if necessary, and the project has reached the beginning of the design stage.

It has been found economical to draw up a schematic run of lines of the entire job as taken from the flow charts, superimposed upon the preliminary plot plan. When complete, this drawing shows immediately which lines are too long and offers visual inspection of lines that appear inflexible. Equipment can be shifted to correct such faults. The designers and all

others concerned obtain an over-all picture of the project.

Another similar study is made for the underground lines. From this study catch basins, area drains, valve pits and junction boxes may be located with respect to equipment and preliminary locations of foundations. The invert* or centerline elevations can be established and those lines serving the unit should be located at the battery limits. These two drawings also serve the useful purpose in allowing the placement of a blanket order for all materials that are to be used. This blanket order can be a closer approximation of the amount of material to be used compared with earlier estimates made from the flow charts.

The base line elevation of the tower is of primary importance since this has a direct effect on the height of the structure. It is governed by the bottoms pump suction head, headroom requirements of all lines crossing the area between the structure and other pieces of equipment, and the size of the beams supporting the structure or towers. The pump suction head includes friction loss through fittings, valves and pipe. Allowances for these losses are to be taken into account by the designer when setting up the equipment.

* Invert elevation of a pipe is the elevation of the lower inside pipewall surface. It is an important figure, since it indicates drainage possibilities.

***THE DESIGN** of process plants is a complex business. In the larger engineering organizations the work is handled by a number of design teams which specialize in certain phases—processing, instrumentation, hydraulics, electrical equipment, piping and a variety of other special skills. In smaller organizations engineers with wide experience may design complete plants, of course, with little in the way of departmental specialization. This article is written from the viewpoint, however, of the engineer associated with a large group—a major company design organization. It is assumed that process design will be handled by an individual or group responsible for that work only, and that over-all mechanical design and construction will be supervised by a "job engineer" (who may also have process responsibility). Piping design will be conducted by a group working from engineering flow sheets developed and approved by the job engineer, and from drawings of pumps, compressors, other process equipment, fabricated vessels — drawings made or procured by other groups and supplied to the piping groups for their all-important layout work. This piping group has a major responsibility in achieving satisfactory design results. Its problems are not just piping, of course, but also involve equipment layout and a variety of decisions involving everything from operating convenience to fluid flow considerations. Still another group checks piping stresses. This article, however, is written from the viewpoint of the piping designer—so called because a more accurate descriptive name would require too many words.*

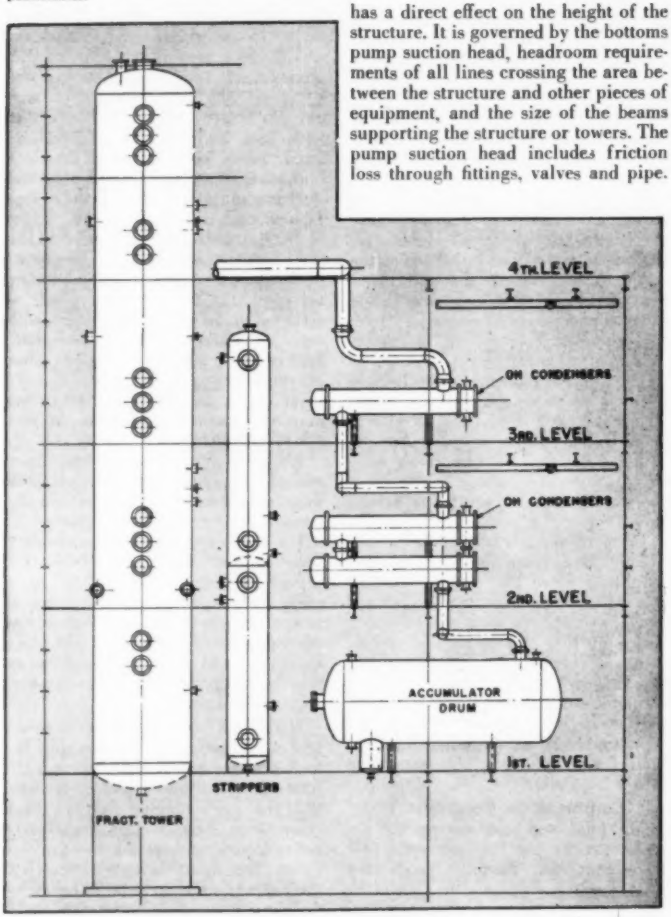

Figure 2. Expanded Elevation.

The headroom requirements of lines is usually established by the customer, which would be with respect to surrounding plants, maintenance facilities, etc. The size or depth of beams is determined by the steel department at a later date; however, an experienced designer can closely estimate this factor. The aforementioned conditions, then, establish the elevation of the first level and the height of the lower tangent line of the tower.

The first layout to be made of the structure should be an expanded elevation (an elevation in one plane) to show all the equipment in the structure without regard to orientation or location with respect to each other as shown in Figure 2. This ultimately will serve as a means of getting the customer's approval of the arrangement regarding platform elevations, accessibility of instrumentation, manholes, piping, and methods of tube bundle or equipment maintenance and removal.

The initial step to produce this expanded elevation is to make individual templates or "dummies" of the various pieces of equipment as shown on the process design sketches if working sketches are not available at this early stage. These templates should be drawn to a convenient scale and should show:

1) All trays, manholes, nozzles or connections on the towers and strippers.
2) Liquid inlet line, manhole, nozzles or connections and supports of the accumulator drum.
3) Shell nozzles and piping of the overhead vapor condensers, including trolley beams and trolleys for the handling of the condenser heads, channels, bundles and shells.

The bundles of the overhead vapor condensers are heavy and present a major problem for their removal. When shell and tube equipment is located in the structure, the structure should be designed so that the entire unit, intact or in its components, can be lifted and lowered to the ground by a hoist or crane, subject to the customer's selection. This necessitates additional height and length to the structure. The vendor's prints of these condensers usually indicate the weights and sizes of the component parts so the handling problem can be solved.

Generally it will be found that the bundle is the heaviest of all the parts and a hoist and trolley should be selected to take care of this weight plus an additional 25 percent, the usual impact factor. The vendor's catalog will show exactly how much space is required for their hoists and trolleys, and several also indicate the recommended sizes of beams. This arrangement, together with a simple arrangement of the trolley equipment for handling of the heads, is then added to the template of the condensers to complete it.

It will be noted that in Figure 2 the pairs of trolleys and trolley beams were used due to the removal arrangement. The bundles in this case were to be lowered to the ground by two trolley beams at 90 degrees to the axis of pulling. Pull beams should also be provided.

The actual expanded elevation drawing, being the "assembly drawing" of all the templates, can now be begun. It is to be recalled, the first level of the structure as well as the lower tangent line elevation of the tower were previously established. Superimposed over the template of the tower is placed a vellum sheet upon which the drawing is to be made. A light line is then drawn the full length of the sheet with proper relation to the tower tangent line elevation. This, then, represents the first level of the structure.

If this unit is to be a fractionator as shown in Figure 1, then the stripper, flash drum (if required by process) and the accumulator drum should be placed on this level. If the accumulator is so large as to require excessively heavy steel or a wider and longer structure, then it should be supported alongside the tower structure on its own supports from grade.

The templates of the stripper, accumulator and any other pieces of equipment located in the structure are then slid under the vellum sheet and adjusted until the proper base elevations are established. By adding insulation and clearances to the large inlet line of the accumulator and by the designer's estimate of the depth of steel necessary to support the equipment above, another light line is drawn across the sheet. This, then, represents the second platform level of the structure.

The same procedure is applied to the overhead vapor condenser template complete with trolley beams and piping. The third platform level will then be established. Similarly will the fourth by the template of the overhead feed exchangers. The levels of any other type of oil unit or chemical plant may be fixed in exactly the same manner.

When all the levels have been fixed, an effort should be made to make all the levels equidistant from each other if at all possible without adding too much additional height to the structure. This will add to "eye appeal" and will also eliminate many steel details, thereby reducing drafting costs.

When the operating level elevations are finally established, adjustments may be necessary to eliminate interferences between tower nozzles and steel. This may be done by adjusting the tower height, tower nozzles, or platform levels individually or collectively to correct undesirable conditions.

The portion of the tower above the highest platform level of the structure is next to be considered. Having all the manholes and nozzles shown on the template, the various wing platforms can be established with respect to the tower connections and manholes. Here, too, equidistant elevations is preferable if at all possible.

The topmost platform is set directly over the tower head so that accessibility may be had for the vapor line joint, relief valves, vents, instruments, etc. Either a davit on the uppermost wing or a trolley beam above the topmost platform is usually required to handle trays, valves, pipes, etc. for either erection or maintenance.

This, then, completes the expanded elevation. Since this tower structure is a major portion of the plant, an approval or comment from the customer regarding this arrangement is recommended. This can be done directly at the designer's board. Since this layout contains every major point requiring decisions, the customer, through his representative, can visualize the ultimate design and make his comments in a short time.

Comment on Final Sheet

The final step is to correct the arrangement as per his comments and trace over the "dummies" onto the final sheet. A print of this is sent to his office for formal comment and approval.

From this point on, the templates serve very effectively in piping layouts and finished arrangements drawing by simply tracing them over when the time arrives, thereby saving considerable drafting time.

Concurrently with the designing of the expanded elevation of the tower structure, the plans sizing the length and width of the structure and the location of the equipment is developed, both designers working hand in hand to insure every problem being discussed and solved. Freehand piping sketches and the schematic yard piping layout are also used in determining the size of the structure. In Figure 1 the overhead feed exchangers and the overhead vapor condensers with their arrangement of piping were the criteria. Sketches of trays and nozzles and their orientations are necessary so that accessibility to valves and manholes are fully considered and, if need be, a discussion with the process engineers would be in order in the event trays should be rearranged to bring the nozzles and manholes nearer to the structure side of the tower. Now that all the levels and size of structure have been definitely determined and fixed, plans and elevation drawings indicating platform levels, proposed steel bracing, vessels and all the piping 12-inch and larger are drawn. Prints of these drawings are then sent to the steel department to start the steel designs and for placing blanket orders for steel. One set of these prints is returned to the piping department with main beam and column sizes indicated. It becomes a relatively simple matter of comparing the steel department's notations to the estimated steel of the expanded elevation and make the necessary corrections.

All the major departments now have enough information to proceed with their subsequent calculations and designs.

Up to this point all the studies, sketches, and drawings made by the piping department have been of a preliminary nature. They were useful in assuring the designers and customer that no major changes could take place and that the actual piping layouts can now be started, usually from the topmost level down.

Here the tower orientation sketches become important in establishing the locations and sizes of the wing platforms, for locating connecting ladders, and for pre-arranging vertical pipe runs. Once these factors are clearly defined and understood by the designer, the piping layouts are started, the plans being first, to be followed by the elevations and sections when progress in plans is made.

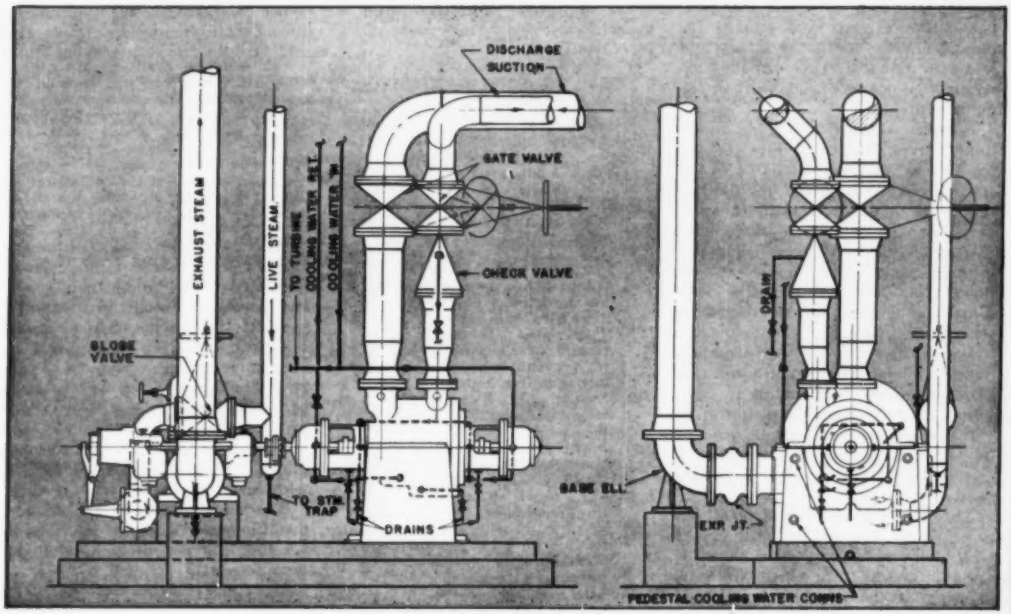

Figure 4. Typical Piping at Pumps. Left, Side Elevation. Right, Front Elevation.

No attempt will be made to analyze each line as developed, but a few points regarding eye appeal, proper design and operational preferences will be mentioned here.

For instance, under eye appeal:

1) Piping runs either in horizontal or vertical directions should be grouped where possible. This will facilitate their support and improve their appearance.
2) It is impractical due to flexibility to connect lines from nozzle to nozzle as a straight run. Loops or the rerouting of lines to acquire the desired softness, if not planned systematically, will become very noticeable and every effort should be made to blend them in with the surrounding lines or steel.

Under proper design, consider:

1) An effort should be made to locate as many valves as possible within hand reach.
2) Make-up flanges to be located within easy access.
3) Pipe runs should be planned to keep all fittings to a minimum without any sacrifice to flexibility.
4) The superheated steam line to the tower and stripper should be free of pockets, have some provisions for warm-up blow-offs while bringing the steam and its piping system to the operating temperature to avoid slugs of condensate from being introduced into the towers. If pockets are unavoidable, steam traps should be installed and inspected periodically, especially at initial steam stripping.

Operational and maintenance preferences in response to requests from the field:

1) All control valves, where permissible by process, should be located either at grade or on the first platform level.
2) Orifice flanges to be readily accessible for the replacement of the metering plate.
3) Control valve sets to be properly drained on either side.

An original preliminary location for the pumps was established in the proposed plot plan and the schematic arrangement of yard lines. At that time no attempt was made to determine their sequence, but now, having the tower structure established, this can be done. Usually pumps are located on the basis of the runs of the suction lines, greatly considering their flexibility in maintaining minimum allowable forces at the pump nozzles as well as mantaining the NPSH of the pump requisitioned for the service.

There are several methods in locating pumps with respect to each other. Oftentimes the customer has preferences which should be followed. Therefore, a check-off list is formed:

1) Height of paving in the pump area.
2) Minimum height of pump foundations above the finished floor or paving.
3) Suction or discharge nozzles lined up.
4) Driver or liquid ends of pump foundations lined up.
5) Steel of driver or liquid ends of pumps lined up.
6) Centerline of pump shafts lined up, using the largest pump as the basis.
7) Minimum aisle space between obstructions.
8) Minimum operating aisle width in front and rear of pumps.
9) Expansion joints on the steam and exhaust steam for turbine driven pumps.
10) Remote control turbine trips.
11) Permanent or temporary strainers at suction nozzles.
12) Handling for dismantling and maintenance.

When the selection of methods has been made, the location and sequence of the pumps are determined by sketches, using the schematic yard arrangement, pump prints as available at this time, and the layouts as made of the tower structure.

Here the designers of the tower structure piping and the pump piping keep close contact with each other, offering each other suggestions and changes to insure proper piping.

As per the recommendations of the pump and turbine manufacturers, all nozzles are to be free of all piping forces. This can be done on side suction and discharge pumps with ease by suitable anchors at the base, but on vertical suction and discharge pumps it becomes a difficult and, in some cases, an impossible condition to satisfy. Therefore, in these cases, it is resolved to approve some forces at the pumps, but kept to a minimum; smaller pumps to have less than larger pumps. A rule of thumb that has proven successful over a period of years is to allow 80 pounds per inch of nozzle circumference, or, 250

pounds per inch of nozzle diameter, but not to exceed 1500 pounds for pumps having nozzles 6 inches and larger in diameter. This will then determine the degree of flexibility of the pump piping.

Isometric sketches indicating all fittings, valves, lengths of pipe, etc. of the suction lines are submitted to the stress department for the exact calculations of these forces at the nozzles. Recommended changes of these lines will be noted, and if found necessary, piping sketches will be revised accordingly. This then, according to flexibility and terminal forces, determine the suction lines.

One further check is needed before the preliminary designing can be called complete, and that is to compare the actual available suction head with the net positive suction head of the pump requisitioned or purchased. For hot liquids there must be a positive head on the pump.

The isometric sketches note all fittings, valves, size and run of the pipes while the pump design data notes the specific gravity, absolute viscosity, capacity of the pump in gpm., and the net positive suction head. The procedure is as follows:

1) Convert all fittings, valves, etc. to equivalent lengths of pipe to arrive at a total equivalent length.
2) From a convenient specific gravity table using kinematic viscosity and gpm., convert actual pipe inside diameter to that as used in the table by:

$$\left(\frac{\text{inside dia. of pipe in table}}{\text{inside dia. of actual pipe}}\right)^5 = \text{dia. factor}$$

then

3) Kinematic viscosity = dia. factor $\times \frac{\text{absolute viscosity}}{\text{specific gravity}}$. (Kinematic viscosity is also known as centistokes).
4) From the same table using kinematic viscosity, gpm., and specific gravity, the friction head loss per 1000 feet of pipe is found.
5) Loss of head per 1000 feet $\times$ total equivalent length equals friction head loss.
6) Knowing that the static head is the difference of elevation in feet between the tangent line of the vessel and the centerline of the pump, then
7) The available head = static head-friction head.

The available head should be equal to or more than the net positive suction head of the pump. If found to be less, the pump engineer should be notified to purchase a pump with a higher net positive suction head rating or the vessel from which the pump takes its suction should be raised. As a rule, no drastic design changes are necessary since the tangent line rather than the liquid level, which is a few feet higher, is used in calculating the available head.

The preliminary design work now being completed, the finished layout is undertaken, considering each pump individually.

In "piping up" these pumps, there are several points to be remembered:

1) The suction piping is of great importance, and, aside from misalignment of the pump, creates most of the pump troubles. Since a very small amount of air leaking into the suction side of the pump reduces the pumping capacity, every effort is to be made to eliminate air pockets.
2) The size of the suction pipe should never be less than the size of the pump suction nozzle. It is desirable to have the line one, or at most, two sizes larger.
3) There must be some form of strainer at the pump suction nozzle to prevent foreign matter from damaging the impeller.
4) Suction and discharge piping to favor the operating pump rather than its spare.
5) Spool pieces should always be placed on the suction side for temporary strainer or pump removal. (The check valve can be used as this spool on the discharge side.)
6) The pump should not be placed directly behind a column unless there is enough room in front of the pump for pulling the impeller shaft.
7) The discharge pipe should never be smaller than the discharge nozzle. It is desirable to have it one or two sizes larger. The reducers ("increasers" in this case) will effectively reduce hydraulic losses and should be placed as close to the pump discharge nozzle as possible.

Exchanger and Yard Piping

In order to have established the preliminary plot plan and the schematic run of yard lines, it is evident the exchanger group was discussed and clarified with respect to the method of handling the tube bundles and shells. Figure 1 shows mobile equipment for the exchanger removal was intended.

The use of mobile equipment in preference to a large heavy structure for the removal of the exchangers and their tube bundles at grade has decided advantages and is fast becoming the accepted method. Mobile equipment always had to be used in transporting the exchangers to the repair shop, even though the structure was existent. By improvement in the mobile units, it is now possible to remove channels, pull bundles, raise shells, etc. without the use of a trolley structure, thereby saving considerable steel. Since the piping to and from the exchangers necessitates a pipe alley, it is placed at the head end, extending beyond the back end of the exchangers. This pipe alley should be as low and narrow as required and may prove difficult for the use of mobile equipment for the removal of the heads. This may raise the piping a slight amount to provide enough room for a small trolley, hoist and sling.

Together with the customer's preference of exchanger handling, the following should be decided:

1) Will the exchangers be lined up on a common centerline or will the shell bottoms or shell tops line up?
2) Minimum aisle space between units.
3) Will the area be paved? Sloped? If paved and sloped, what is the elevation of the high point?
4) Should the control valve sets be located between individual exchangers or at some desired distance away, grouped together as a station?

With the vendor's prints of the units and the flow charts, piping sketches are made to determine their spacing and sequence. Every effort should be made to line up the channel nozzles, shell nozzles on the channel end, and both front and rear supports to minimize drafting costs as well as to improve their appearance. The vendor's prints are marked up for these conditions and returned to him for consideration. As a rule, this can be done with few exceptions.

The actual piping is an individual condition and cannot be described line for line, but the following should be considered:

1) All lines interconnecting exchangers should be grouped to facilitate supporting which adds to eye appeal.
2) Proper flexibility of all lines.
3) All the valving, where possible, to be within hand reach.
4) All lines to and from channels should have their valves or a break-up flange several inches inboard of the tube sheet joint to facilitate the channel removal without excessive dismantling of pipe.
5) All lines and their by-passes to be free of pockets, if possible.
6) All lines to have their drains or pumpouts so located as to isolate a unit for repair or removal.
7) Auxiliary pipe support columns for all lines directly over the exchangers should be kept close to the exchangers and on the same centerline of the front and rear exchanger supports, thereby employing the same foundations.

The "piping up" of the exchanger group now completes all the units that are found in the average pipe still. The remaining work is to connect all the lines between these groups into a pipe bank known as yard piping.

In flow it is desirable to avoid pockets in lines either for drainage in case of shutdown or to prevent air-logs in lines before and during operation. Therefore, each line is considered individually in this respect: as an example, a pump suction line should have its high point at the vessel and its low point at the pump and conversely with pump discharge lines.

Having analyzed each line, the arrangement and elevation of critical lines can be established, group together as many as possible, thereby reducing the pipe supports to a minimum.

***PRACTICAL PROCESS** engineers working with heavy oil vacuum distillation equipment use some weird and wonderful procedures to "calculate" the relation between temperature and percentage vaporization or condensation at reduced pressures. The methods available in the literature for correcting equilibrium data for pressures do not adequately cover the ranges employed in commercial refinery distillation equipment, and most designers have accordingly developed their own systems. These are usually a combination of the correction methods given in the literature and whatever actual plant "operating points" are available to the particular engineer, plus that individual's guesses and personal prejudices. This article, while not recommended by the authors as the solution to all problems of flash equilibrium at reduced pressures, should nevertheless help to bridge some of the gaps, and the correlations are described as more correct than the common assumption that vacuum flash curves are parallel to atmospheric flash curves.*

***Mr. Van Winkle** is associate professor of chemical engineering and **Mr. Okamoto** is a graduate student, both at the University of Texas. Material herein is from a thesis submitted in partial fulfillment of the requirements for a degree of M.S. Ch.E.*

Correlation of Equilibrium Flash And True Boiling Point Distillation Curves at Sub Atmospheric Pressures

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EQUILIBRIUM flash vaporization curves are used extensively in the petroleum industry in design calculations as well as in the study of operating conditions in existing equipment. The elaborate equipment necessary and the tedious operations required for the evaluation of experimental flash vaporization data make these data difficult to obtain. For this reason attempts have been made to correlate the flash vaporization curves with other more readily obtainable distillation curves such as the ASTM or TBP (true boiling point). Numerous empirical correlations have been developed[10, 11, 13, 15, 16, 21] based primarily on atmospheric experimental data. Katz and Brown[7] also present a theoretical correlation at atmospheric pressure.

A survey of the literature shows relatively few equilibrium flash vaporization data[6, 8, 11, 14, 15] and these are at atmospheric pressure. There are three sets of experimental data published by Bahlke and Kay,[1] Edmister, Reidel and Merwin[4] and Edmister and Pollock[5] at pressures above atmospheric. Edmister and Pollock[5] have presented an empirical method of predicting the equilibrium flash vaporization curves of petroleum fractions at various pressures above atmospheric. They also show the effect of pressure on the equilibrium flash vaporization curve.

Published vacuum equilibrium flash vaporization data are not available in the literature in so far as is known. Because of the lack of data at vacuum conditions, it is customary to establish the vacuum equilibrium flash vaporization curves by drawing the curves at the lower pressures parallel to the atmospheric flash curve and through the 50% boiling point temperature, transposed by means of the n-paraffin hydrocarbon vapor pressure charts.

In the absence of experimental values, theoretical equilibrium flash vaporization data and true boiling point distillation data at sub-atmospheric pressure have been calculated and correlated and the results are reported here. Ideal behavior of the vapor and liquid is assumed in the calculations.

Selection of Mixtures and Conditions

All pressures used throughout this investigation are expressed in millimeters of mercury and the temperatures in degrees Fahrenheit and degrees Rankine as indicated. The pressure range covered is from 3000 to 10 millimeters of mercury. The basic assumption made in these calculations is that the liquid and vapor behave ideally throughout this pressure range. The pressures selected for the calculation of the true boiling point and flash vaporization curves were 3000, 1000, 760, 400, 100, and 10 millimeters of mercury. Two mixtures were examined mathematically at additional pressures of 500, 200, and 50 millimeters of mercury. A plot of these data indicated that the additional pressures were not necessary to show the effect of pressure on the characterizing slopes of the curves. Consequently, they were omitted in the remaining calculations. It is recognized that the assumption of ideal behavior for the vapor state is not entirely satisfactory for all cases over the pressure range used, although the assumption of ideality in the liquid state should introduce no significant error. Pressures up to 3000 millimeters of mercury were included to show the continuity of trends in the correlations above atmospheric pressure.

Nine hypothetical hydrocarbon mixtures were selected to cover as wide a range as possible in vaporization curve slope, composition, and molecular weight. The selection was based on availability of vapor pressure data for the components. The compositions of the mixtures are listed in Table 1. Data on the properties of the components were included in the mixtures taken from the publications of Brown, et al.[2] and Rossini, et al.[18]

The major hydrocarbon types composing crude petroleum are paraffins, naphthenes, and aromatics. The relative amount of each type varies depending upon the source of the crude oil. It was originally intended to select mixtures typical of crude petroleum from California, Pennsylvania, Texas, and the Mid-Continent areas. Mixture 1 represents a typical Mid-Continent petroleum containing fifteen of the major components as reported by Rossini in the API Research Propect 6.[17]

Because of the lack of information regarding typical compositions of the crude oils from the other sources, the eight additional mixtures were selected to cover a wide range in relative percentage of paraffinic, naphthenic and aromatic hydrocarbons. The relative percentages of the three types of hydrocarbons present in the nine mix-

TABLE 1
Composition of Hydrocarbon Mixtures

Mixture 1:

Components	Formula	Mole Fraction
1. n-Hexane	C_6H_{14}	0.089
2. 2-Methyl-hexane	C_7H_{16}	0.050
3. 2-Methyl-heptane	C_8H_{18}	0.049
4. Methyl-cyclopentane	C_6H_{12}	0.050
5. cis-1,3-Dimethyl-cyclohexane	C_8H_{16}	0.125
6. Methyl-cyclohexane	C_7H_{14}	0.050
7. m-Xylene	C_8H_{10}	0.033
8. 1,2,4-Trimethyl-benzene	C_9H_{12}	0.023
9. n-Heptane	C_7H_{16}	0.107
10. n-Octane	C_8H_{18}	0.099
11. Cyclohexane	C_6H_{12}	0.075
12. Benzene	C_6H_6	0.007
13. Toluene	C_7H_8	0.037
14. n-Nonane	C_9H_{20}	0.118
15. n-Decane	$C_{10}H_{22}$	0.088

Mixture 2:

1. n-Pentane	C_5H_{12}	0.125
2. 2,3-Dimethyl-butane	C_6H_{14}	0.125
3. Methyl-cyclopentane	C_7H_{14}	0.125
4. 2-Methyl-hexane	C_7H_{16}	0.125
5. Toluene	C_7H_8	0.125
6. Ethyl-cyclohexane	C_8H_{16}	0.125
7. n-Nonane	C_9H_{20}	0.125
8. 1,2,4-Trimethyl-benzene	C_9H_{12}	0.125

Mixture 3:

1. n-Pentane	C_5H_{12}	0.125
2. n-Hexane	C_6H_{14}	0.125
3. 2-Methyl-hexane	C_7H_{16}	0.125
4. 2-Methyl-heptane	C_8H_{18}	0.125
5. m-Xylene	C_8H_{10}	0.125
6. 1,2,4-Trimethyl-benzene	C_9H_{12}	0.125
7. Undecane	$C_{11}H_{24}$	0.125
8. Dodecane	$C_{12}H_{26}$	0.125

Mixture 4:

1. n-Pentane	C_5H_{12}	0.125
2. n-Hexane	C_6H_{14}	0.125
3. Toluene	C_7H_8	0.125
4. n-Nonane	C_9H_{20}	0.125
5. Undecane	$C_{11}H_{24}$	0.125
6. Tridecane	$C_{13}H_{28}$	0.125
7. Pentadecane	$C_{15}H_{32}$	0.125
8. Heptadecane	$C_{17}H_{36}$	0.125

Mixture 5:

1. n-Pentane	C_5H_{12}	0.125
2. n-Heptane	C_7H_{16}	0.125
3. n-Nonane	C_9H_{20}	0.125
4. Dodecane	$C_{12}H_{26}$	0.125
5. Hexadecane	$C_{16}H_{34}$	0.125
6. Eicosane	$C_{20}H_{42}$	0.125
7. Pentacosane	$C_{25}H_{52}$	0.125
8. Triacontane	$C_{30}H_{62}$	0.125

Mixture 6:

1. n-Pentane	C_5H_{12}	0.125
2. n-Hexane	C_6H_{14}	0.125
3. n-Heptane	C_7H_{16}	0.125
4. n-Octane	C_8H_{18}	0.125
5. n-Nonane	C_9H_{20}	0.125
6. n-Decane	$C_{10}H_{22}$	0.125
7. Undecane	$C_{11}H_{24}$	0.125
8. Dodecane	$C_{12}H_{26}$	0.125

Mixture 7:

1. Cyclopentane	C_5H_{12}	0.125
2. n-Hexane	C_6H_{14}	0.125
3. Cyclohexane	C_6H_{12}	0.125
4. Methyl-cyclohexane	C_7H_{14}	0.125
5. Toluene	C_7H_8	0.125
6. Ethyl-cyclohexane	C_8H_{16}	0.125
7. m-Xylene	C_8H_{10}	0.125
8. n-Nonane	C_9H_{20}	0.125

Mixture 8:

1. n-Pentane	C_5H_{12}	0.125
2. Cyclopentane	C_5H_{10}	0.125
3. Benzene	C_6H_6	0.125
4. Toluene	C_7H_8	0.125
5. Ethyl-benzene	C_8H_{10}	0.125
6. n-Propyl-benzene	C_9H_{12}	0.125
7. n-Decane	$C_{10}H_{22}$	0.125
8. Undecane	$C_{11}H_{24}$	0.125

Mixture 9:

1. n-Octane	C_8H_{18}	0.20
2. n-Decane	$C_{10}H_{22}$	0.20
3. Dodecane	$C_{12}H_{26}$	0.20
4. Tetradecane	$C_{14}H_{30}$	0.20
5. Hexadecane	$C_{16}H_{34}$	0.20

tures selected are presented in Table 2.

Calculation of Physical Properties

The methods of calculating the necessary physical properties of the nine mixtures were as follows:

1. Molecular Weight

$$\text{Molecular Weight} = (X_1M_1 + X_2M_2 + X_3M_3 + \frac{\quad}{\quad})$$

where: X = Mole fraction of components
M = Molecular weight of components

The molecular weight of the mixture is additive on the mole fraction basis.

2. Specific Gravity

(60/60) (at 60° F. referred to water at 60° F.)

$$\text{Sp. Gr. (60/60)} = (W_1G_1 + W_2G_2 + W_3G_3 + \frac{\quad}{\quad})$$

where: W = Weight fraction of components
G = Specific gravity of components (60/60)

The specific gravity of the mixture is additive on the weight fraction basis.

3. Characterization Factor (K)

a) $$K_{component} = \frac{(T_b)^{1/3}}{\text{Sp. Gr.}}$$

where: T_b = Normal boiling point of component (°R.)
Sp. Gr. = Specific gravity of component (60/60)

b) $$K_{mixture} = (K_1W_1 + K_2W_2 + K_3W_3 + \frac{\quad}{\quad})$$

where: K = Characterization factor of components
W = Weight fraction of components

The characterization factor of the mixture is additive on the weight fraction basis.

4. Pseudo-Critical Temperature (T_c) (°R.)

$$T_c = (X_1T_{c_1} + X_2T_{c_2} + X_3T_{c_3} + \frac{\quad}{\quad})$$

where: X = Mole fraction of components
T_c = Critical temperature of components (°R.)

TABLE 2
Composition of Mixtures Hydrocarbon Types

MIXTURE	Paraffin (Percent)	Naphthenes (Percent)	Aromatic (Percent)
1	60	30	10
2	50	25	25
3	75	....	25
4	87.5	....	12.5
5	100	....	....
6	100	....	....
7	25	50	25
8	37.5	12.5	50
9	100	....	....

TABLE 3
Physical Properties of the Mixtures

MIXTURE	Molecular Weight	Specific Gravity (60/60)	K	Tc (°R.)	Pc (mm Hg.)
1	107.6	0.7393	12.11	1028.9	22,884
2	99.4	0.7574	11.74	1011.3	24,921
3	115.7	0.7494	12.19	1045.3	20,906
4	146.5	0.7535	12.52	1117.0	18,476
5	219.4	0.7778	13.08	1244.0	14,255
6	121.2	0.7153	12.73	1035.9	18,677
7	97.2	0.7789	11.40	1026.2	26,924
8	104.7	0.7937	11.43	1047.3	26,366
9	170.3	0.7531	12.79	1183.2	14,579

K = Characterization factor.
Tc = Pseudo-critical temperature.
Pc = Pseudo-critical pressure.

The pseudo-critical temperature of the mixture is additive on the mole fraction basis.

5. Pseudo-Critical Pressure (P_c) (mm Hg.)

$$P_c = (X_1P_{c_1} + X_2P_{c_2} + X_3P_{c_3} + \frac{\quad}{\quad})$$

where: X = Mole fraction of components
P_c = Critical pressure of components (mm Hg.)

The pseudo-critical pressure of the mixture is additive on the mole fraction basis. The preceding five physical properties of the nine mixtures studied are given in Table 3.

True Boiling Point Curves

The true boiling point curves are plots of temperature vs. the percent vaporized at constant pressure. By assuming perfect fractionation of the mixture into its individual components a stair-step

TABLE 4
True Boiling Point Distillation Curve Data
Mixture 1

RANGE Percent Vaporized	Component	Temperature °F. Pressure (mm Hg.) 1000	760	500	200	100	10
0 — 8.9	n-Hexane	171	155.7	132	88.5	60	−12.5
8.9—13.9	Methyl-cyclopentane	177	162.5	137	92	61.5	−11.5
13.9—14.6	Benzene	193	176	153	108	76	4
14.6—22.1	Cyclohexane	195	177	153	107.5	78	1.5
22.1—27.1	2-Methyl-hexane	212	194	169	122	92	14
27.1—37.8	n-Heptane	226	209	183.5	137	106.5	28
37.8—42.8	Methyl-cyclohexane	231	213.7	188	138	107	26
42.8—46.5	Toluene	250	231	206	157.5	126	45
46.5—51.4	2-Methyl-heptane	261	243.5	218	168.5	137	54
51.4—63.4	cis-1,3-Dimethyl-cyclo-hexane	286.5	248	221.5	170	137	52
63.4—73.8	n-Octane	276.5	258	231	182	150	66.5
73.8—77.1	m-Xylene	301	282	254	203	169.5	83
77.1—88.9	n-Nonane	322.5	303	274.5	223.5	189	102
88.9—91.2	1,2,4-Trimethylbenzene	354	336.5	306	251.7	221.8	122
91.2—100	n-Decane	364.5	345	315	262	226.5	135

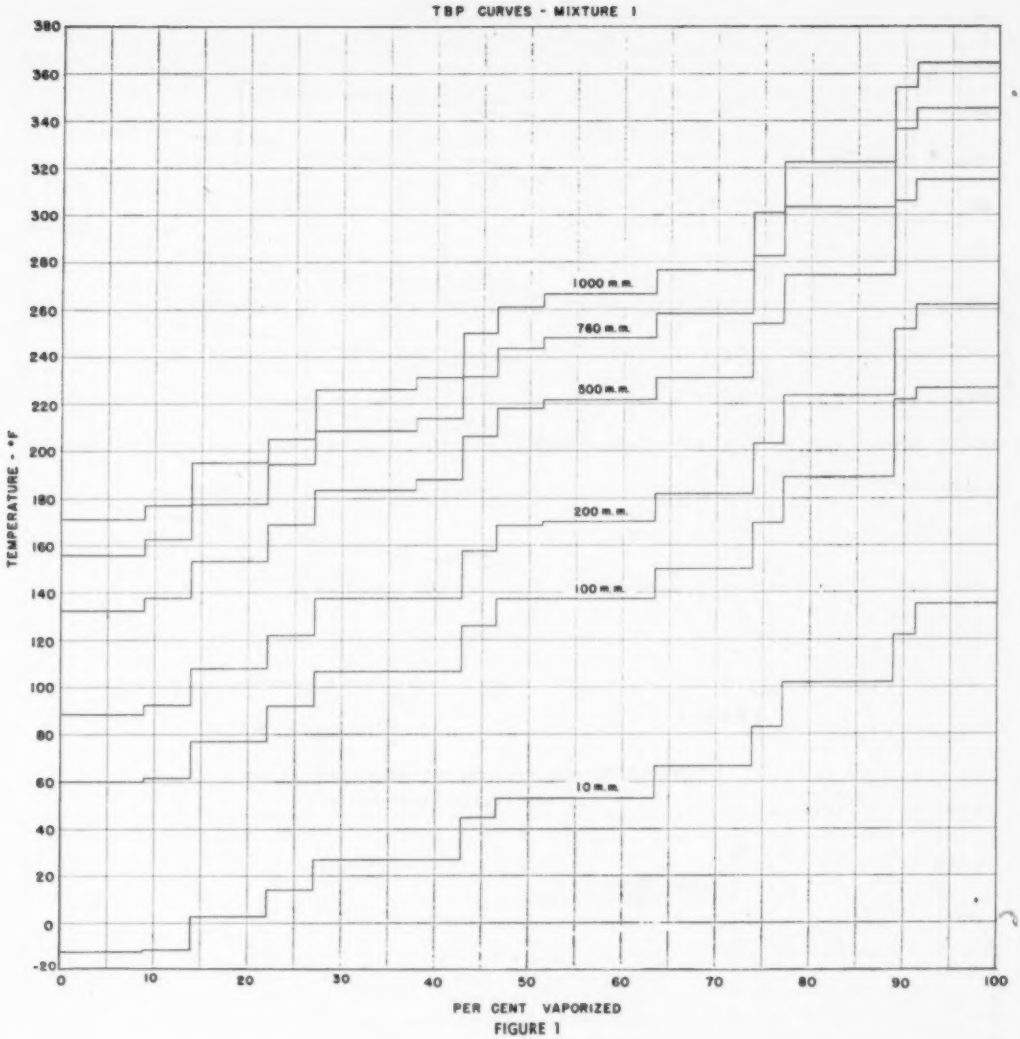


FIGURE 1

type of curve results. The theoretical true boiling point curves of hydrocarbon mixtures are very readily obtained, knowing the chemical composition and the vapor pressure data for all components over the desired temperature range. The vapor pressure data used were those of Brown, et al.[3] and Rossini, et al.[19] Rossini's vapor pressures cover a range of 10 mm to 1500 mm of mercury. For values needed outside this range the vapor pressure curves were extrapolated by use of Othmer's method[12] using n-hexane as the reference material. Data for the true boiling point curves for Mixture 1 are given in Table 4 and the curves are shown in Figure 1.

Flash Vaporization Curves

Assuming the mixtures follow the ideal gas laws, a minimum of six points in the equilibrium flash vaporization curve, including the bubble point and the dew point, were calculated for each mixture at each pressure selected. The trial and error methods of calculation were as follows:

1. Bubble Point

$$\left(\frac{X_1P_t}{P_1}+\frac{X_2P_t}{P_2}+\frac{X_3P_t}{P_3}+\text{————}\right)=1.0$$

where: X = Mole fraction of components
P = Vapor pressure of components (mm Hg.)
P_t = Total Pressure (mm Hg.)

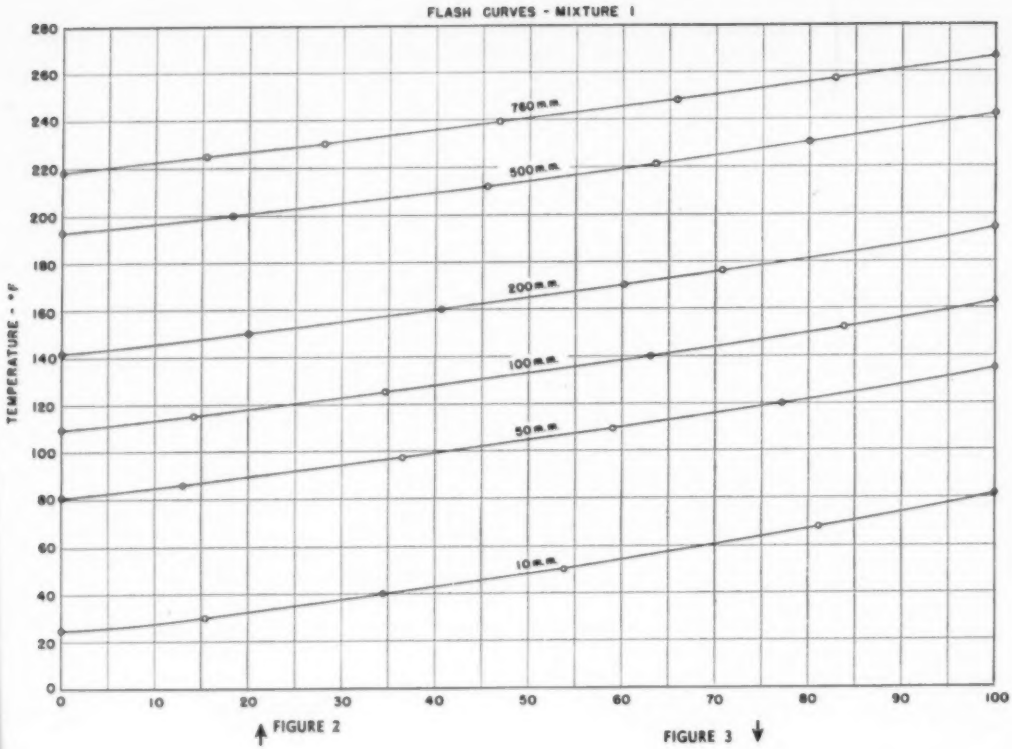
This is a trial and error solution. At a given pressure, when the correct bubble point temperature is assumed, the above equation will be satisfied.

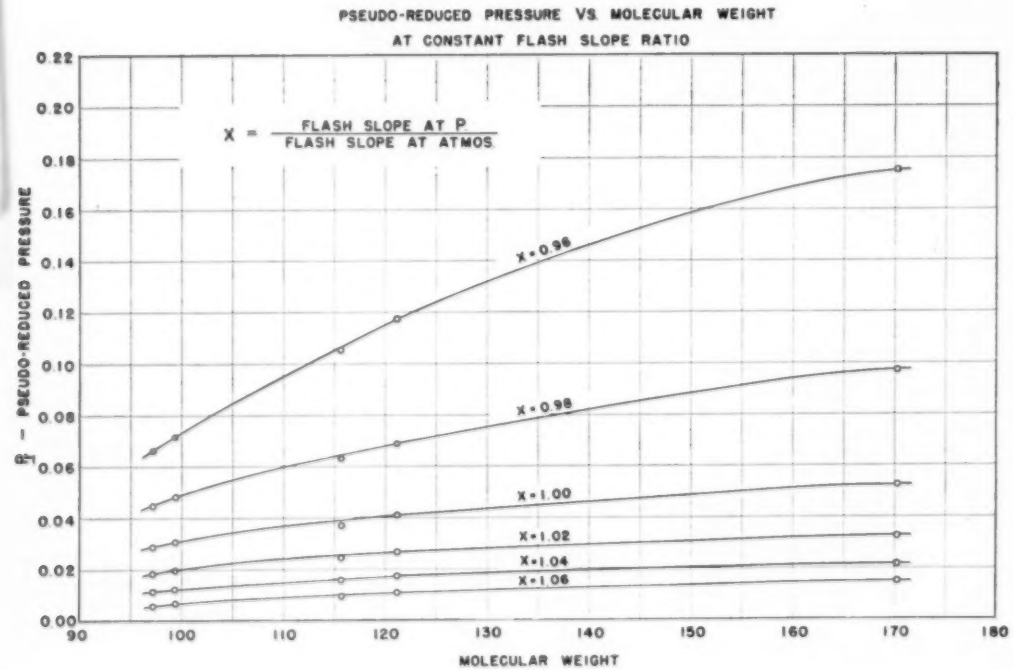
2. Dew Point

$$\left(\frac{X_1P_t}{P_1}+\frac{X_2P_t}{P_2}+\frac{X_3P_t}{P_3}+\text{————}\right)=1.0$$

where: X = Mole fraction of components
P = Vapor pressure of components (mm Hg.)
P_t = Total pressure (mm Hg.)

This is a trial and error solu-


FLASH CURVES - MIXTURE 1
TEMPERATURE - °F
760 m.m.
500 m.m.
200 m.m.
100 m.m.
50 m.m.
10 m.m.
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
0
10
20
30
40
50
60
70
80
90
100
FIGURE 2
FIGURE 3


PSEUDO-REDUCED PRESSURE VS. MOLECULAR WEIGHT
AT CONSTANT FLASH SLOPE RATIO
X = FLASH SLOPE AT P / FLASH SLOPE AT ATMOS.
PI - PSEUDO-REDUCED PRESSURE
MOLECULAR WEIGHT
X = 0.96
X = 0.98
X = 1.00
X = 1.02
X = 1.04
X = 1.06
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
90
100
110
120
130
140
150
160
170
180

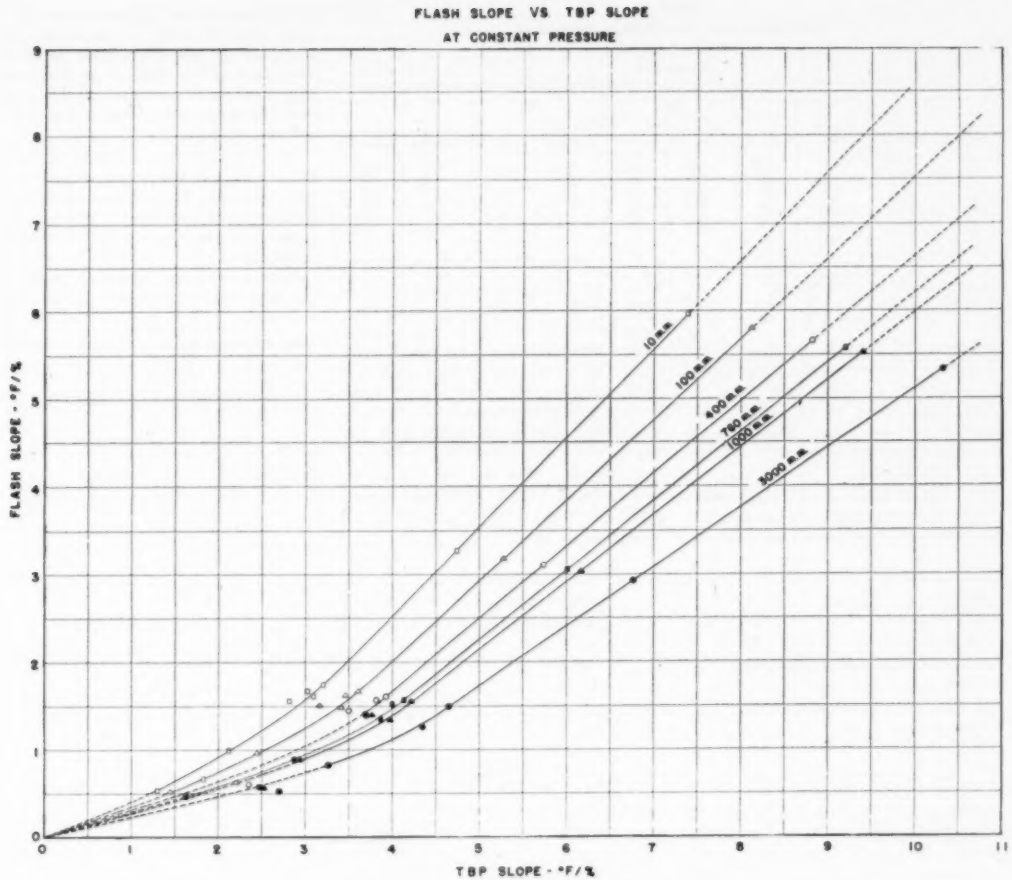


FIGURE 4

tion. At a given pressure, when the correct dew point temperature has been assumed, the above equation will be satisfied.

3. Intermediate Points. The intermediate points were calculated from material balances assuming that Raoult's and Dalton's laws are valid.

$$\left(\frac{X_1P_t}{P_t+P_1\frac{V}{L}}+\frac{X_2P_t}{P_t+P_2\frac{V}{L}}+\frac{X_3P_t}{P_t+P_3\frac{V}{L}}+\text{————}\right)=(L)$$

where: X = Mole fraction of components
P = Vapor pressure of components (mm Hg.)
P_t = Total pressure (mm Hg.)
V = Percent vaporized
L = Percent in liquid residue

This is also a trial and error solution. The method is described briefly as follows: With a basis of 100 moles of original charge and at the selected total pressure, (L) is assumed. This fixes the value of (V) from a material balance (V = 100 — L). A temperature is assumed and the vapor pressure of the components are determined from vapor pressure charts. The correct solution is obtained when the assumed value of (L) and the computed value of (L) from the above equation are equal. The percent vaporized (V) is obtained from a material balance (V = 100 — L).

The calculated data for the flash curves for Mixture 1 are given in Table 5 and the curves are presented in Figure 2.

Slope

The slopes of both true boiling point curves and flash vaporization curves were determined using the temperatures of the 10 percent and 70 percent vaporization points.

$$\text{Slope}=\frac{(T\ ^\circ F.\text{ at }70\%)-(T\ ^\circ F.\text{ at }10\%)}{60\%}=\ ^\circ F/\%$$

Previous investigators have used this definition of slope because it more accurately characterizes the distillation curve. This investigation also shows that the 10 and 70 slope is a good average for the entire curve. The ratio of the slope at a given pressure (P) to the slope at atmospheric pressure for both flash and true boiling point curves were obtained directly from the calculated slopes.

Pseudo-Reduced Pressures

The pseudo-reduced pressure was

TABLE 5
Equilibrium Flash Vaporization Curve Data
Pressure (mm Hg.)
Mixture 1

760		500		200		100		10	
Percent Vaporized	Temp. °F.	Percent Vaporized	Temp. °F	Percent Vaporized	Temp. °F.	Percent Vaporized	Temp. °F.	Percent Vaporized	Temp. °F.
B.P.	218.3	B.P.	192.8	B.P.	141.6	B.P.	109.3	B.P.	24.5
15.4	244.6	18.3	200.	20.0	150.	14.2	115.	15.4	30.
28.0	230.0	45.5	212.	40.6	160.	34.7	125.	34.5	40.
46.6	239.0	63.5	221.	60.2	170.	63.0	140.	53.8	50.
65.8	248.0	80.0	230.	70.7	176.	83.8	152.	81.1	68.
82.8	257.	D.P.	242.	D.P.	194.2	D.P.	162.8	D.P.	81.5
D.P.	266.6	.....	.....	.....	.....	.....	.....	.....	.....

calculated by the following:

$$P_r = \frac{P}{P_c}$$

where: P = Total pressure (mm Hg.)
P_c = Pseudo-critical pressure of mixture (mm Hg.)

The pseudo-critical pressure was computed by averaging on a mol fraction basis the critical pressures of the pure components.

Calculated values used in the correlations are presented in Tables 6 and 7 for Mixture 1. Similar values were obtained for the other mixtures. The validity of the correlations presented depends primarily on the accuracy of the vapor pressure data. The values used were the latest and presumably the most reliable ones available.[3,19] With respect to the components used in the mixtures a maximum variation in the vapor pressures reported by Brown[3] and Rossini[19] of 5 percent was noted. Extrapolated values were used where no other values were available.

The slope of the true boiling point curves decrease with decrease in pressure. Also the ratio of the slopes decrease as the pseudo-reduced pressure decreases. The flash slope *increases* with decrease in pressure and the slope ratio increases with decrease in pseudo-reduced pressure.

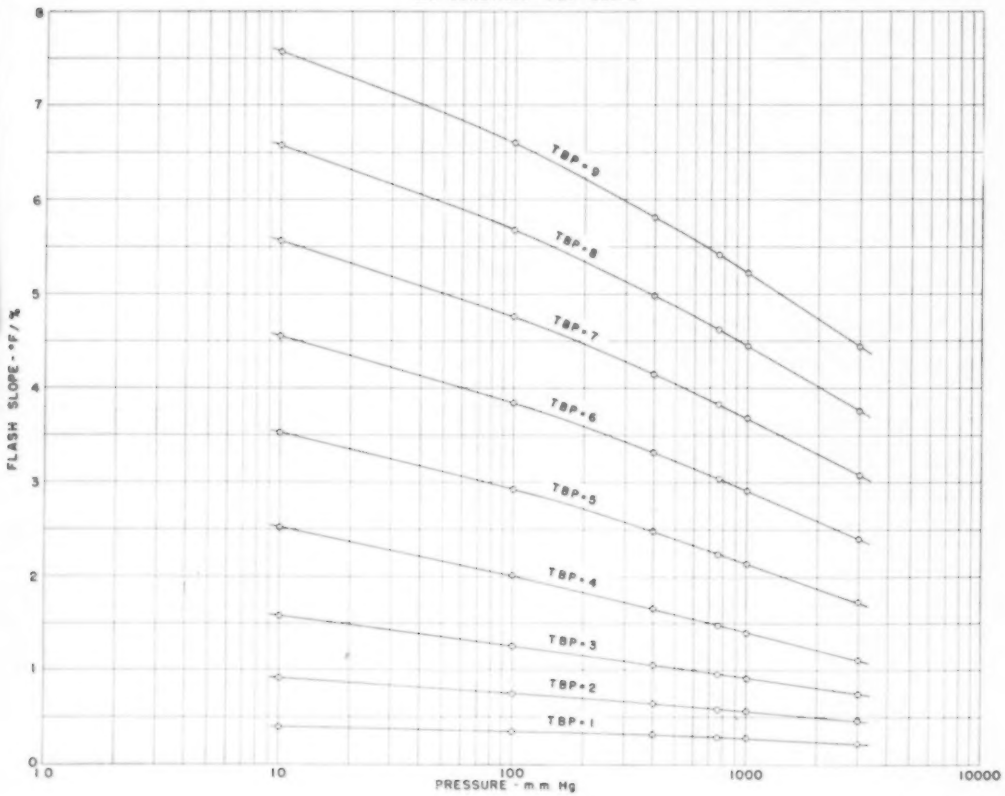
All correlations indicated a variation with the character of the mixtures studied. Molecular weight appeared to be the best correlating variable of the mixture characteristics investigated.

Figure 3 is a plot of pseudo-reduced pressure versus molecular weight with

Table 6
True Boiling Point Distillation Correlation Data
Mixture 1
P_r = pseudo-reduced pressure

Pressure (mm Hg.)	Slope (°F/%)	Slope at P_r / Slope at Atmos.	50 Percent (°F.)	P_r
760	1.593	1.000	243.5	0.0332
500	1.560	0.979	218	0.0218
200	1.497	0.940	168.5	0.0087
100	1.475	0.926	137	0.0044
10	1.300	0.816	54	0.0004

FIGURE 5
FLASH SLOPE VS. PRESSURE
AT CONSTANT TBP SLOPE



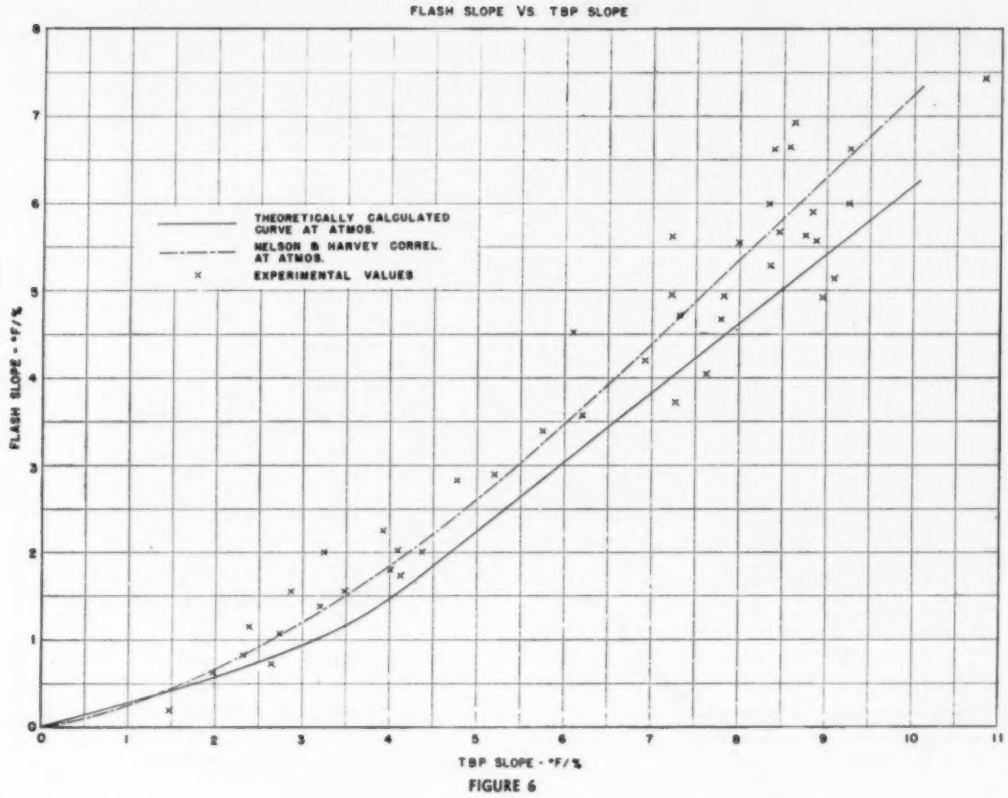


FIGURE 6

the ratio of the flash slopes as a parameter.

The relationship between the true boiling point slope and flash vaporization slope shows very definitely the influence of pressure. Heretofore, the relationship was correlated at atmospheric pressure and the correlation was assumed to be valid at all pressures below atmospheric. Figure 4 indicates that this assumption is incorrect and that at sub-atmospheric conditions the pressure at which the distillation or vaporization is conducted should be considered. Figure 5 represents a plot of the slope of the flash vaporization curve versus the log of the absolute pressure at constant true boiling point distillation curve slope.

Nelson and Harvey[9] recently published a correlation relating atmospheric flash vaporization and true boiling point data based on slopes and 50 percent distillation temperatures. Figure 6 compares the results of this investigation at atmospheric pressure with the Nelson and Harvey correlation. In addition, points derived from published experimental data are included on the plot.

Figure 7 shows the relationship of the 50 percent boiling points of the true boiling point and flash vaporization curves computed in this investigation, the recommended correlation of Nelson and Harvey, and experimental points from the literature. It is indicated that the 50 percent boiling point is a valid correlation point not only as atmospheric pressure as previous investigators have found but also throughout the sub-atmospheric pressure range.

TABLE 7
Equilibrium Flash Vaporization Correlation Data
Mixture 1

Pressure (mm Hg.)	Slope (°F./Percent)	Slope at P / Slope at Atmos.	50 Percent Point (°F.)	B.P. (°F.)	D.P. (°F.)	D.P. 50 Percent Point (°F.)	P_r
760	0.464	1.000	240.5	218.3	266.6	26.1	0.0332
500	0.477	1.028	214.3	192.8	242.0	27.7	0.0218
200	0.497	1.070	164.5	141.6	194.2	29.7	0.0087
100	0.510	1.100	133.0	109.3	162.8	29.8	0.0044
50	0.522	1.124	104.3	80.5	134.7	30.4	0.0022
10	0.530	1.142	48.0	24.5	81.5	33.5	0.0004

Conclusions

The true boiling point curves decrease in slope with decrease in pressure from 3000 to 10 millimeters of mercury. This decrease in the true boiling point curve slope with decrease in pressure is a function of the molecular weight of the mixture being distilled.

The flash vaporization curves increase in slope with decrease in pressure from 3000 to 10 millimeters of mercury. This increase in the flash vaporization curve slope with decrease in pressure is a function of the molecular weight of the mixture being flash vaporized.

The 50 percent boiling points of the true boiling point and flash vaporization curves are essentially equal throughout the pressure range investi-

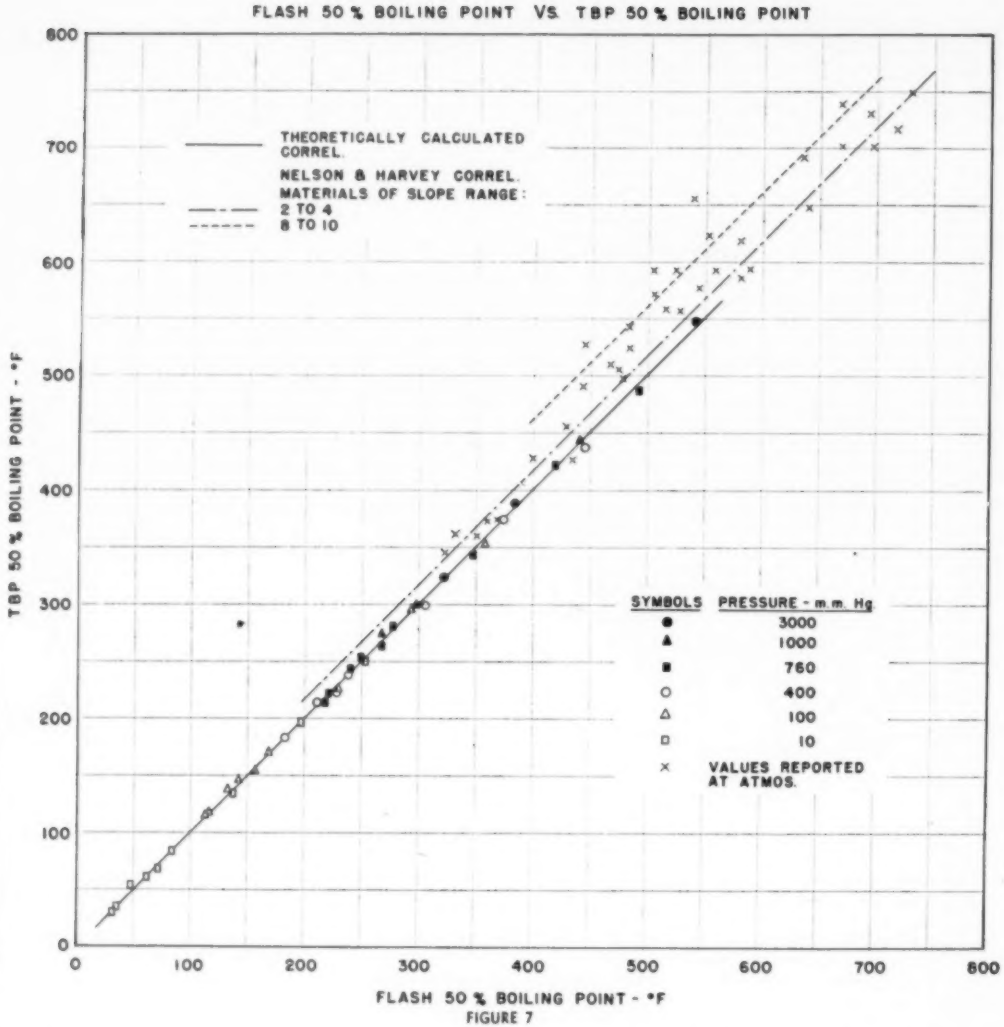


FIGURE 7

gated. Therefore, the relationship between the 50 percent boiling points of the true boiling point and flash vaporization curves is a 45° line at least for mixtures exhibiting reasonably uniform distillation curves.

The correlations presented enable the determination of the sub-atmospheric flash vaporization curves more correctly than was possible before under the assumption that vacuum flash curves are parallel to the atmospheric flash curves.

There is some question as to the advisability of relying too strongly on the correlations presented here in considering petroleum stocks whose distillation curves exhibit abnormal curvature. However, it is believed that a greater accuracy will be attained in using these correlations than is possible by the older methods.

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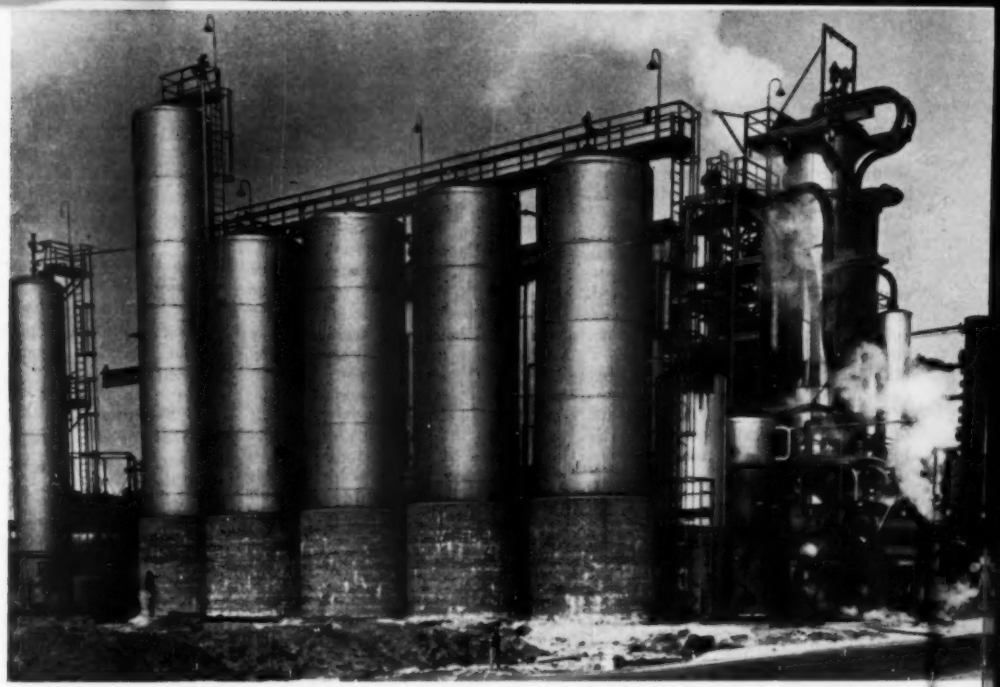

Benzol-Ketone Dewaxing Plant in the Socony-Vacuum Oil Company, Inc.'s, Paulsboro, N. J., Plant.

Lubricating Oil Additives

PART III. OILINESS CARRIERS

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THE lubricant is expected to reduce friction and to prevent wear of the rubbing surfaces by maintaining a film which eliminates direct metal to metal contact. When clearances are large and the lubricating oil film relatively thick the friction between the surfaces is dependent entirely on the internal resistance or viscosity of the lubricant, and the resulting phenomena can be analyzed by the laws of hydrodynamics covering the field of "fluid lubrication." However, if the two surfaces are separated by a very thin film of lubricant the laws of hydrodynamics cease to apply. The resulting conditions have not yet been completely analyzed and understood and are treated separately under the general subject of "boundary lubrication." Finally the two surfaces may be in direct contact with each other, a condition which results in bearing failures. The related phenomena are referred to as "dry lubrication."

The dividing line between the fluid and boundary lubrication is at the point where the laws of hydrodynamics stop to apply. This point may be determined as follows: Equations developed for fluid lubrication include a dimensionless parameter:

$$\frac{ZN}{P}$$

where:
Z—absolute viscosity, $(F)(T)(L)^{-2}$
N—number of revolutions per minute, $(T)^{-1}$
P—load per unit of projected area, $(F)(L)^{-2}$

When this parameter is plotted against the observed friction a straight line is obtained if the conditions correspond to those of fluid lubrication. However, a certain point is reached when the experimental values cease to coincide with the theoretical curve. At

***OILINESS AGENTS** were the first additives developed for use in lubricating oils. For more severe service extreme pressure lubricants and anti-welding agents are employed. Although the oiliness agents are helpful when conditions of boundary lubrication are encountered, their indiscriminate use is not always warranted or desirable. Notwithstanding a considerable amount of experimental work done on this subject, many of the problems connected with the use of oiliness agents remain unanswered and conflicting results are often obtained with different testing equipment.*

The number of patents pertaining to oiliness agents is very great. For easy reference they are tabulated under various headings and alphabetically. Most of the recommended substances are of polar or slightly acidic and corrosive type requiring adjustments in quantities added to the oil for protecting the engine from excessive corrosion and wear. Because of the multi-functional nature of many additives their exact classification is often difficult, if not impossible.

this point the region of boundary lubrication begins.

While in fluid lubrication viscosity of the lubricant determines friction between the two sliding surfaces, in boundary lubrication substances having the same viscosity may have a different effect on the friction coefficient. This is an evasive property of lubricants which has not been formulated in standard units and is referred to as "oiliness." It is defined as that property of the lubricant which causes a difference in friction when two lubricants of the same viscosity at the temperature and pressure of the film are used under identical conditions.[1] The lubricant giving less friction is considered as the one possessing greater oiliness.

The matter is complicated by the fact that oiliness depends not only on the lubricant itself but on a number of other variables. It varies with the nature of materials forming the bearing surfaces. Superfinish increases the load carrying capacity but friction may rise if extra highly polished surfaces are employed. The method of preparing and cleaning surfaces is therefore of much importance in oiliness measurements. Surfaces which are slightly oxidized on contact with air will give different results from those free of such films. Even the nature of the atmosphere surrounding the experimental set-ups may influence the observed conditions. This demonstrates the difficulties encountered in measuring oiliness of lubricants and explains contradictory results which may be obtained by using different equipment or by varying the experimental procedures. It is also not unusual that different testing devices may produce contradictory results by rating some lubricants in the opposite order.

In fluid lubrication a decrease in the viscosity of a lubricant decreases friction. However, in boundary lubrication a reduction in viscosity is accompanied by an increase in friction. This generates additional heat which cannot be removed by freely circulating the lubricant through the bearings because of very small clearances. As a result of the temperature rise viscosity of the film is reduced further causing additional rise in friction.

Occasionally conditions are encountered when none of the known lubricants are capable of maintaining the film between the metal surfaces because of extremely high pressures involved, and direct metal to metal contacts become inevitable. For instance in lubrication of automobile gears pressures between the gear teeth may be as high as 400,000 psi. with rubbing velocities from 0 to 300 feet per minute. Under such conditions the main function of the lubricant is not to provide a fluid film which it cannot do but to prepare the surfaces for service by forming a protective coating on the metal. This is accomplished by the use of anti-welding agents. In the absence of these agents the bearing temperature would rise until it reaches that of the lower melting-point metal and the excess heat would be absorbed by the latent heat of fusion. The anti-welding agents hinder possible formation of alloys and insure continuous lubrication.

Summary of Discussion

Briefly the above discussion may be summarized as follows: At low pressures the lubricant is capable of protecting bearings irrespective of the tenacity with which it adheres to the metal. At higher pressures the ability of the oil to adhere to the metal becomes of increasingly greater importance as otherwise it may be squeezed out from between the rubbing surfaces. At extremely high pressures the lubricant must act chemically on the metal surfaces forming a suitable coating to prevent possible seizure. The anti-welding agents cannot be thus considered true lubricants and their description is therefore omitted although in some instances it is somewhat difficult to differentiate between them and sub-

(Text Continued on Page 126)

Duo-Sol Unit of Socony-Vacuum's Paulsboro Plant. This unit is used for solvent extraction of impurities and other materials from lubricating oil stocks.

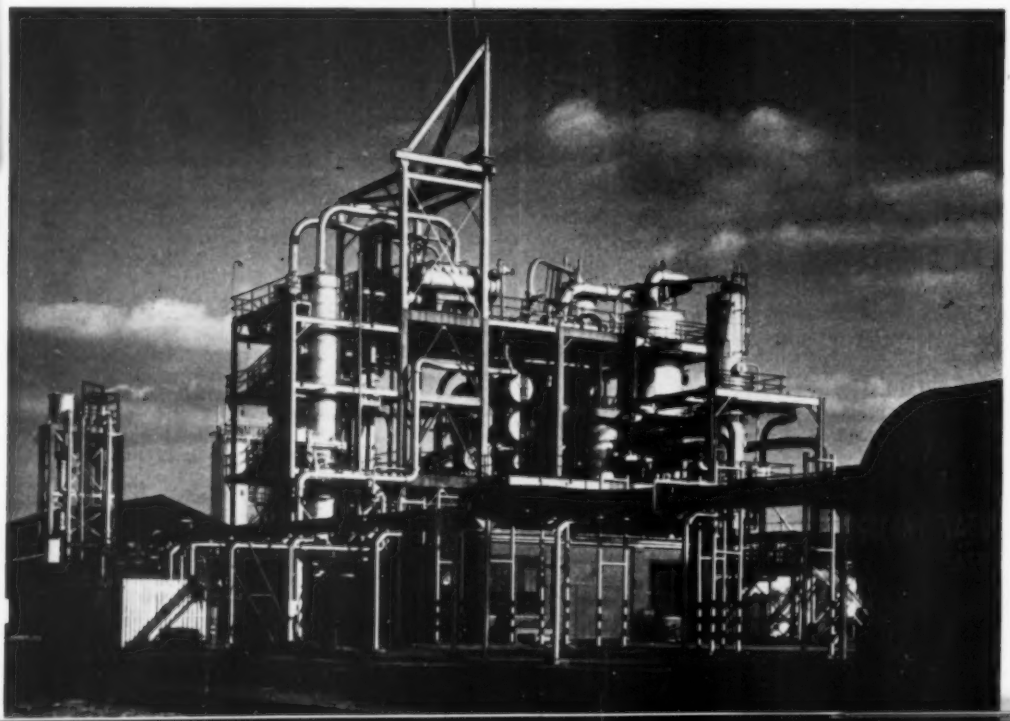

TABLE 9
Oiliness Carriers and Related Additives

Substance	U.S. Patent	Date	Inventor
Metal Compounds:			
Alkali metal sulfides, benzyl chloride and chlorobenzyl chloride	2,273,471	2-17-42	Kimball, R.H.
Aluminum stearate and hydroxybutyloxyethyl ether.	2,260,341	10-28-41	Schott, J. E.
Aluminum, calcium or lead naphthenate and chlorinated phenol.	2,276,341	3-17-42	Prutton, C. F.
Aluminum, cobalt or nickel derivatives of alkylated aromatic compounds containing oxygen or sulfur.	2,417,087	3-11-47	Prutton, C. F.
Aluminum soaps of acids present in oxidized wax.	2,202,364	5-28-40	Wiesevich, P. J.
Aluminum or zinc stearate, rapeseed and castor oils.	2,144,460	1-17-39	Townsend, W. E. and Maxwell, R. O.
Aluminum or zinc oxide and zinc stearate.	2,131,138	9-27-38	Gassert, A. E.
Antimony or bismuth compounds and derivatives of sulfur and chlorine.	2,348,217	5- 9-44	Waugh, S. P.
Antimony pentasulfide, stannic sulfide or mercuric sulfide.	2,421,543	6- 3-47	Cook, J. F.
Diethyl arsenic phenyl-stearate	2,288,268	6-30-42	Lincoln, B. H.
Barium octyl, decyl or dodecyl salicylate monosulfide.	2,311,931	2-23-43	Cook, E. W. and Thomas, W. D., Jr.
Calcium, lead or aluminum salt of a chlorinated naphthenic acid.	2,169,158	8- 8-39	Lincoln, B. H. and Henriksen, A.
Calcium chloride phenylstearate	2,239,953	4-29-41	Fairlie, M.
Calcium chlorophenylmercaptostearate, condensation product of chlorobenzene and oleic acid and similar substances.	2,223,127-9	11-26-40	Prutton, C. F.
Calcium phenyl stearate and chlorinated wax.	2,222,938	11-26-40	Fairlie, M.
Calcium phenyl stearate and chlorinated naphthalene.	2,222,964	11-26-40	Vobach, A. C.
Calcium soap of dichloro fatty acid, chlorostearic acid or synthetic petroleum acids containing halogen, sulfur or phosphorus.	2,225,365-7	12-17-40	Bray, U. B.
Calcium soap of phosphonic acids	2,298,080	10- 6-42	Clarke, P. S. and Flannan, M. T.
Cupric alcoholate of tripropylphosphine and similar metallic compounds.	2,199,944	5- 7-40	Van Peski, A. J. and Van Melsen, J. A.
Cupro-bromide or butyl sulfide and alkenyl succinic acid.	2,187,873	5- 9-39	Van Peski, A. J. and Moser, F. R.
Earth alkali metal phenolate sulfides used for reducing corrosiveness of chlorine or sulfur compounds.	2,424,204	7-15-47	Zimmer, J. C. and McNab, J. G.
Heavy metal naphthenate and sulfurised methyl abietate.	2,220,843	11- 5-40	Johnson, J. W.
Heavy metal soaps of phosphorised wax hydrolysates.	2,411,032	11-12-46	Engelke, E. F. and Odell, W. W.
Iron oxide or sulfide (colloidal)	2,290,032	7-14-42	Burk, R. E.
Lead naphthenate and sulfurised jojoba oil.	2,212,899	8-27-40	Flaxman, M. T.
Lead soap and corrosive sulfur	2,202,394	5-28-40	Morway, A. J.
Lead soap of oxidised petroleum acids and a sulfur compound.	2,242,174	5-13-41	Burk, R. E. and Lankelma, H. P.
Magnesium stearoyl benzoate	2,330,239	9-28-43	Prutton, C. F.
Metal compounds containing metal to carbon bonds, halogen and sulfur.	2,234,566	11-16-43	Lincoln, B. H.
Molybdenum sulfide	2,156,803	5- 2-39	Cooper, H. S. and Damerell, V. R.
Oxygen compounds treated with phosphorus pentasulfide and neutralised with amines, ammonia or metals.	2,419,153 3,419,153	4-15-47 4-15-47	Musselman, J. M. and Lankelma, H. P.
Potassium ethylanthate reacted with perchloromethylmercaptan and similar reaction products.	2,247,042-6	6-24-41	Berger, H. G., Badertscher, D. E. and Seger, F. M.
Sodium chloroacetate and chlorinated wax condensation product.	2,309,336	1-26-43	Byrkit, G. D.
Sodium or potassium salt of an organic acid and chlorinated wax.	2,395,457	2-26-46	Byrkit, G. D.
Stannic chloride and a mercaptan substituted fatty acid reaction product.	2,088,193	7-27-37	Evers, W. L.
Tin salt of sulfurized carboxylic acid, diphenylboron mercaptostearate, triamylammonium mercaptostearate and similar compounds.	2,257,750	10- 7-41	Lincoln, B. H. and Byrkit, G. D.
Zinc soaps	2,214,534	9-10-40	Dombrow, B. A. w
Borates:			
Carboethoxyundecyl diethylborate	2,333,871	11- 9-43	Lincoln, B. H. and Byrkit, G. D.
Chlorophenylboric acid dibutyl ester	2,413,718	1- 7-47	Lincoln, B. H. and Byrkit, G. D.
Chloropropylborate	2,154,098	4- 11-39	Loane, C. M. and Shoemaker, B. H.
Silica Compounds:			
Para-tolyl silicon trichloride	2,129,281	9- 6-38	Lincoln, B. H. and Byrkit, G. D.
Silica aerogel	2,260,625	10-28-41	Kistler, S. S.
Tetrachloropropyl silicate	2,242,400	5-20-41	Loane, C. M. and Shoemaker, B. H.
Hydrocarbons:			
Cyclic compound containing alkyl radicals.	2,363,880	11-28-44	Lieber, E. and Cashman, A. F.
Montan wax (bleached)	1,787,951	1- 6-31	Pungs, W. and Frese, E.
Pennsylvania residuum extracted with acetone.	2,139,668	12-13-38	Breth, F. W. and Kinsel, A.
Oxygenated Compounds:			
Acetic esters of monohydric alcohols	2,113,752	4-12-38	Wiesevich, P. J.
Acetylated castor oil	2,118,341	4-26-38	Mikeska, L. A. and Turner, L. B.

Substance	U.S. Patent	Date	Inventor
Oxygenated Compounds—Continued			
Acids obtained by oxidising synthetic oils produced by polymerising olefins.	2,128,574	8-30-38	Van Peski, A. J. and Coltof, W.
Alpha-hydroxybiphanyl	2,117,076	5-10-38	Bennett, H. T. and Prather, C.
Benzaldehyde, salicyl aldehyde or benzoic acid.	2,134,554	10-25-38	Grobel, L. P.
Butyl furoate	2,113,754	4-12-38	Zimmer, J. C. and Morway, A. J.
2-carbomethoxy-4-hydroxy-phenol	2,164,393	7- 4-39	Evans, E. A.
Coconut oil	2,201,484	5-21-40	Farrington, B. B. and Humphreys.
Diethyl xanthyl ethyl ether	2,161,584	6- 6-39	Moran, R. C. and Fuller, E. W.
Esterified alcohols	2,370,299	2-27-45	Farrington, B. B.
Esters of lower alcohol and acids from oxidized hydrocarbon oils.	2,096,390	10-19-37	Burwell, A. W. and Kempe, A.
Ethyl oleate or methyl stearate	2,210,140	8- 6-40	Colbeth, I. M.
Fatty acids condensation products with coal tar fractions.	2,077,066	4-13-37	Rainton, A. W. and Christensen, C. E.
Heptadecyl phenyl ketone	2,204,661	6-18-40	Cantelo, R. C.
Hydrogenated and oxidised menhaden oil.	2,087,603	7-20-37	Mikeska, L. A. and Smith, C. F.
Hydroxyacids, esterified with aliphatic alcohols.	2,370,300	2-27-45	Farrington, B. B.
Hydroxylated acetal	2,143,142	1-10-39	Dietrich, M. A.
Isopropyl alcohol and soybean oil	2,115,354	4-26-38	Wasson, J. I.
Isopropyl ester of acids from oxidized wax.	2,243,420	5-27-41	Frolich, P. K.
Isopropyl esters of petroleum naphthenic acids.	2,234,541	12-10-40	Frolich, P. K.
Maleic anhydride condensation product with diolefins.	2,149,857	3- 7-39	Mikeska, L. A. and Rosen R.
Methylenebisgallic or methylenedisalicylic acid.	2,194,478	3-26-40	Moser, F. R. and Nijk, D. R.
Methylene diresorcinol	2,267,337	12-23-41	Moser, F. R. and Nijk, D. R.
Methyl phenyl stearate	2,211,163	8-13-40	Rice, H. E., Jr.
Methyl or ethyl oleate or abietate	2,186,646	1- 9-40	Lincoln, B. H. and Steiner, W. L.
Mixed ketones	2,033,543	3-10-36	Rainton, A. W. and Christensen, C. E.
Naphthenic acid ester of diethylene glycol monobutyl ether.	2,173,117	9-19-39	Johnson, J. W., Jr.
Octyl acid phthalate, naphthenyl acid phthalate and similar substances.	2,158,096	5-16-39	Wernts, J. H.
Oleic acid	1,319,129	10-21-19	Southcombe, J. E. and Wells, H. M.
Oxidised paraffin wax	1,826,439	10- 6-31	Stryker, D.
Oxidised paraffin or amorphous wax or hydrocarbon oil.	1,932,381 2,043,923	10-24-33 6- 9-36	Gallsworthy, B. Burwell, A. W.
Phenylbenzoylbenzoic acid derivatives.	2,231,248	2-11-41	Bowden, F. P.
Phthalic esters	2,215,590	9-24-40	Maverick, G. M.
Stearol	2,274,617	2-24-42	Remy, T. P.
Tertiary butyl ether of o-ethyl-p-cresol.	2,263,663-4	11-25-41	Wasson, J. I. and Smith, W. M.
Wool oil acetic ester	2,121,976	6-28-38	Mikeska, L. A. and Cohen, C. A.
Compounds of Sulfur, Selenium or Tellurium			
Acetothiocephenide	2,278,762	4- 7-42	Bergen, D. E.
Alkyl phenol sulfides, selenides or tellurides.	2,240,314	6-17-41	Mikeska, L. A.
Alkyl xanthic disulfide	2,206,245	7- 2-40	Adams, E. W. and McNulty, G. M.
Aromatic sulfinic acid esters	2,422,243	6-17-47	Knutson, A. T. and Graves, F. F.
Benzothiazole tetrasulfide	2,237,526	4- 8-41	Humphreys, R. L.
2,4-dinitrophenyl thiocyanate	2,094,097	9-28-37	Downing, F. B. and Benning, A. F.
Disulfide from petroleum mercaptans.	2,206,858	6-25-40	Mikeska, L. A. and Miller, F. L.
Dixanthyl dialkyl thioether	2,323,797	7- 6-43	Cook, E. W.
Esters containing sulfur, selenium or tellurium directly connected to an aromatic ring.	2,096,905	10-26-37	Lieber, E.
Heptadecyl phenyl thioketone	2,204,661	6-18-40	Cantelo, R. C.
Hydrogenated sulfurised abietic acid derivative.	2,217,794	10-15-40	Morway, A. J. and Zimmer, J. C.
Isoamyl ester of benzene mono-or di-sulfonic acid.	2,168,262	8- 1-39	Klemgard, E. N. and Ricketts, V. L.
Mercaptobenzothiazole	2,201,258	5-21-40	Busse, W. F.
Nicolet and de Milt's acid	1,850,561	3-22-32	Moran, R. C.
Organic polysulfides	2,189,271	1- 9-40	Pevere, E.
Selenium oxide or selenocyanate	2,359,270	9-26-44	Shutt, R. S. and Watkins, G. R.
Sulfides of ester-substituted aromatic hydroxyl compounds.	2,388,047	10-30-45	Evans, E. A. and Elliott, J. S.
Sulfonated wool oil	2,172,285	9- 5-39	Lincoln, B. H. and Steiner, W. L.
Sulfur (elemental)	167,730	9-14-75	Bartlett, B. F.
	60,829	1- 1-67	Boynton, J. F.
	22,621	1- 8-59	Brown, R. R.
	199,789	1-29-78	Chard, R. J.
	29,243	7-24-60	Chitterling, C.
	120,631	11- 7-71	Denison, G. M.
	287,643	11-30-83	Dimick, G.
	112,453	2- 7-71	Henderson, E. Q.
	41,068	1- 5-64	Hilton, W.
	134,890	1-14-73	Hutchinson, H. R.
	157,848	12-15-74	Mandel, A. G.
	170,581	11-30-75	Mendonca, J. F.
	97,262	11-23-69	Moore, C. S.
	156,714	11-10-74	Scott, J.
	250,009	11-22-81	Smalley, E.
	76,838	4-14-68	Spence, G. O.
	132,379	10-22-72	Williams, J.

TABLE 9 (Continued)
Oiliness Carriers and Related Additives

Substance	U.S. Patent	Date	Inventor
Compounds of Sulfur, Selenium or Tellurium—Continued			
	167,117	6- 8-75	Williams, J.
	179,744	7-11-76	Upper, J. G.
Sulfur and dihydropolycyclic aromatic hydrocarbon reaction product.	2,202,501-2	5-28-40	Magill, P. La F.
Sulfur and alkylated naphthalene	2,228,219	1- 7-41	Steiner, W. L.
Sulfur and naphthalene reaction product.	2,147,578	2-14-39	Hendrey, W. B.
Sulfur and rosin	2,246,415	6-17-41	Potter, R. A.
Sulfurised esters	2,204,538	6-11-40	Lincoln, B. H. and Steiner, W. L.
Sulfurised isobutylene polymer	2,291,404	7-28-42	Morway, A. J.
Sulfurised lard oil	2,246,281-2	6-17-41	Zimmer, J. C. and Morway, A. J.
Sulfurised methyl ester of dimerized conjugated octadecadienoic acid.	2,325,040	7-27-43	Cook, E. W. and Bradley, T. F.
Sulfurised mineral oils	2,206,151-2	7- 2-40	Bennett, H. T.
Sulfurised mixture of tall oil and a fatty acid ester.	2,417,283	3-11-47	Zimmer, J. C. and McNulty, G. M.
Sulfurised monohydric phenol	2,222,643	11-26-40	Zimmer, J. C.
Sulfurised mono-olefin polymer	2,330,858	10- 5-43	Anderson, J. A.
Sulfurised oleyl or sperm alcohol	2,254,756	9- 2-41	Segesseman, E.
Sulfurised phenyl cinnamate	2,357,211	8-29-44	Lincoln, B. H. and Steiner, W. L.
Sulfurised polymers from cracked gasolines.	2,398,271	4- 9-46	Zimmer, J. C. and Morway, A. J.
Sulfurised polymer of rapeseed oil	2,195,549	4- 2-40	Wasson, J. I.
Sulfurised rubber polymer	2,264,830	12-12-44	Towne, C. C.
Sulfurised sperm oil	2,203,507	6- 4-40	Roehner, T. G. and Carmichael, E. S.
Sulfurised sperm oil, tritolyl phosphate, and an alcohol.	2,231,301	2-11-41	Smith, H. G.
Sulfurised unsaturated ketones	2,419,586	4-29-47	Otto, F. T. and Meyer, R. E.
Thiocids	2,073,841	3-16-37	Humphreys, R. L. and Farrington, B. B.
Thianthrene, trithioacetone and similar substances.	2,213,804	9- 3-40	Lincoln, B. H. and Byrkit, G. D.
Thiobenzophenone or benzophenone	2,204,660	6-18-40	Cantelo, R. C.
Thiocarbonates	2,368,670	2- 6-45	Lincoln, B. H. and Byrkit, G. D.
	2,020,021	11- 5-35	Farrington, B. B. and Humphreys, R. L.
Thioketo polysulfide	2,307,307	1- 5-35	Shoemaker, B. H.
Trimethylene-12-disulfide	2,292,456	8-11-42	Lincoln, B. H. and Byrkit, G. D.
Halogenated Substances:			
Chlorinated alcohol	2,137,777	11-22-38	Lincoln, B. H., Steiner, W. L. and Henriksen, A
Chlorinated and phenylated aliphatic derivatives.	2,150,177	3-14-39	Lincoln, B. H. and Byrkit, G. D.
Chlorinated aromatic aldehydes	2,318,013	5- 4-43	Prutton, C. F. and Smith, A. K.
Chlorinated benzene	2,118,214-7	3-24-38	Marsh, W. J. and Spina, J. A.
Chlorinated benzophenone	2,281,597	5- 5-42	Prutton, C. F.
Chlorinated carbon compounds and ethyl abietate.	2,310,971	2-16-43	Lincoln, B. H. and Steiner, W. L.
Chlorinated carnauba wax	2,109,357	2-22-38	Lincoln, B. H. and Henriksen, A.
Chlorinated cottonseed oil	2,372,414	3-27-45	Werder, J. F.
Chlorinated cottonseed oil or castor oil.	2,205,740	6-25-40	Wunsch, J. A. and Marbles, C. A.
Chlorinated cresol	2,213,532	9- 3-40	Prutton, C. F. and Smith, A. K.
Chlorinated dibutyl phthalate	2,353,585	7-11-44	Prutton, C. F. and Smith, A. K.
Chlorinated diphenyl ether	2,137,783	11-22-38	Prutton, C. F. and Smith, A. K.
Chlorinated Edeleanu extract	2,281,705	5- 5-42	Merrill, D. R.
Chlorinated esters	2,298,670	10-13-42	Alleman, G. and Perrine, J. H.
Chlorinated kerosene and an alkylphenol-formaldehyde condensation product.	2,334,594	11-16-43	Zimmer, J. C. and McNulty, G. M.
Chlorinated lard oil and naphthalene condensation product.	1,939,993	12-19-33	Lincoln, B. H. and Henriksen, A.
Chlorinated naphthalene and oxidized petroleum acids.	2,233,683	3- 4-41	Smith, W. A.
Chlorinated oleone	2,284,258	5-26-42	Brooke, B. T.
Chlorinated oxidised hydrocarbon oil.	2,106,554	1-25-38	Lincoln, B. H. and Henriksen, A.
Chlorinated and oxygen-containing hydrocarbon.	2,137,782	11-22-38	Prutton, C. F. and Smith, A. K.
Chlorinated paraffin.	2,119,149	5-31-38	Bishop, W. T.
Chlorinated partially hydrogenated petroleum product.	2,125,169	7-26-38	Marsh, W. J.
Chlorinated polyisobutylene	2,225,318	12-17-40	Morway, A. J. and Miller, F. L.
Chlorinated resorcinol	2,180,008	11-14-39	Lincoln, B. H., Steiner, W. L. and Henriksen, A.
Chlorinated stearic acid	2,157,134	5- 9-39	Lincoln, B. H. and Henriksen, A.
	2,074,338	3-23-37	Lincoln, B. H and Henriksen, A.
Chlorinated stearic acid and diphenyl oxide condensation product.	1,939,979	12-19-33	Henriksen, A. and Lincoln, B. H.
Chlorinated stearone	2,211,687	8-13-40	Brooks, B. T.
Chlorobenzoic acid and a corrosion inhibitor.	2,298,636-40	10-13-42	Prutton, C. F.
Chlorobensophenone	2,223,766	12- 3-40	Lincoln, B. H., Steiner, W. L. and Byrkit, G. D.
Chloro-ester and a hydrogenated derivative of naphthalene.	2,272,470	2-10-42	Lincoln, B. H. and Steiner, W. L.
Chloronaphthalene	2,112,109	3-22-38	Marsh, W. J.
Chloronaphthalene, chlorobiphenyl and similar substances.	2,320,984	6- 1-43	Prutton, C. F.
Chlorophthalic acid	2,251,738	8- 5-41	Lincoln, B. H. and Henriksen, A.

Substance	U.S. Patent	Date	Inventor
Halogenated Substances—Continued			
Condensation products containing halogens.	1,945,615	2- 6-34	Lincoln, B. H. and Henriksen, A.
Condensation products of two halogenated fatty acids or esters.	1,939,994	12-19-33	Lincoln, B. H. and Henriksen, A.
Dichlorocatechol	2,250,384	7-22-41	Lincoln, B. H., Steiner, W. L. and Henriksen, A.
Dichlorocinnamylacetophenone	2,235,860	3-25-41	Williams, N. D.
Dichlorohydroquinone distearate	2,157,078	5- 2-39	Lincoln, B. H. and Byrkit, G. D.
3,3-dichloro-4-hydroxybutanone	2,335,434	11-30-43	Morey, G. H.
Dichlorophenylethyl cinnamate	2,326,315	8-10-43	Williams, N. D.
Dichlorophenyl methyl polysulfide, dichloronaphthyl methyl polysulfide, dichloroanthracyl methyl polysulfide and similar compounds	2,185,009	12-26-39	Babcock, J. H. and Loverde, A.
Dinaphthyl or dixylyl dichloroethylene.	2,161,678	6- 6-39	Klipstein, K. H.
Diphenyldichloromethane	2,308,622	1-19-43	Lincoln, B. H. and Byrkit, G. D.
Fatty chlorides condensation products with coal tar derivaties.	2,033,546	3-10-36	Christensen, C. E. and Selby, W. M.
Fluorinated hydrocarbons	2,291,166	7-28-42	Maag., O. L.
Halogenated alcohols	2,206,573	7- 2-40	Lincoln, B. H., Steiner, W. L. and Henriksen, A.
Halogenated aromatic acids and their derivaties.	2,255,085	9- 9-41	Prutton, C. F. and Smith, A. K.
Halogenated aromatic amines	2,248,925	7-15-41	Lincoln, B. H., Steiner, W. L. and Wolfe, J. W.
Halogenated aromatic hydrocarbons of phenylbenzene type.	2,066,354	1- 5-37	Henriksen, A. and Lincoln, B. H.
Halogenated dicyclohexyl ether	2,137,784	11-22-38	Prutton, C. F. and Smith, A. K.
Halogenated diphenylene oxide	1,936,670	11-28-33	Henriksen, A. and Lincoln, B. H.
Halogenated ester of carbonic acid.	2,387,999	10-30-45	Knutson, A. T. and Graves, E. F.
Halogenated foots oil	2,264,819	12- 2-41	Lincoln, B. H. and Byrkit, G. D.
Halogenated hydroaromatic ketone	2,298,301	10-13-42	Knutson, A. T.
Halogenated organic acids condensation products with halogenated wax.	1,939,995	12-19-33	Lincoln, B. H. and Henriksen, A.
Halogenated and partially hydroxylated organic acids.	2,272,923	2-10-42	Prutton, C. F.
Halogenated organic esters	1,944,941	1-30-34	Lincoln, B. H. and Henriksen, A.
Halogenated paraffin wax	2,119,556	6- 7-38	Prutton, C. F.
Halogenated petroleum oils	2,155,204	4-18-39	Prutton, C. F.
Halogenated petroleum wax	2,126,590	8- 9-38	Valentine, J.
Halogenated phenyl compounds	2,262,773	11-18-41	Lincoln, B. H. and Henriksen, A.
Halogenated "tall oil" condensed with benzene, naphthalene or xylenol.	2,262,809	11-18-41	Lieber, E.
Halogenated terpenes	2,063,857	12- 8-36	Steiner, W. L.
Hydroxy benzyl chloride derivatives	2,415,833	2-18-47	Mikeska, L. A. and Kittleson, A. R.
Methyl chlorostearate and pinene.	2,217,173	10- 8-40	Lincoln, B. H. and Steiner, W. L.
Mono- and di-chlorinated derivatives of xylyl heptadecyl ketone and similar substances.	2,107,905	2- 8-38	Ralston, A. W. and Christensen, C. E.
Octa- or hexa-halopropane	2,316,925	4-20-43	Whittier, W. A. and Stucker, J. B.
Ortho-dichlorobenzene, methyl chlorosalicylate and similar substances.	2,330,238	9-28-43	Prutton, C. F.
Polychlorinated naphthol	2,161,650	6- 6-39	Crowley, M. L.
Tetrabutyl ammonium iodide	2,321,517	6- 8-43	Rosen, R.
Tetrachlorodibenzyl and similar substances.	2,261,862-5	11- 4-41	Whittier, W. A.
Trichlorophenyl stearate	2,157,079	5- 2-39	Lincoln, B. H. and Byrkit, G. D.
Nitrogen Compounds:			
Alkyl phenyl ether of 2,4-dinitrophenol.	2,134,436	10-25-38	Cantrell, T. L. and Turner, J. O.
Alkyl piperidine salts of fatty acids	2,412,956	12-24-46	Barker, G. E.
Aminophenol derivaties of naphthenic acids.	2,205,172	6-18-40	Musselman, J. M. and Lankelma, H. P.
Diphenylamine and tallow oil	2,061,328	11-17-35	Penniman, W. B. D.
Ethyl oleyl carbamate	2,161,615	6- 6-39	Dietrich, M. A.
Hydroquinine, hydroquinidine or hydrocinchonine.	2,208,218	7-16-40	Lankelma, H. P.
Naphthenyl allophanate	2,316,903	4-20-43	Van Ess, P. R. and White, E. R.
Nitrated fatty oil or tallow	2,196,101	4- 2-40	Carmichael, E. S., DeGray, R. J. and Prall, J. H.
Nitriles	2,053,045	9- 1-36	Ralston, A. W., Pool, W. O. and Harwood, J.
Nitroaniline	2,136,885	11-15-38	Moser, P. R. and Tuyn, M. C.
Nitroaromatics	2,066,173	12-29-36	Calcott, W. S. and McHarness, R. C.
Phenylethanolamine	2,325,533	7-27-43	Montgomery, J. V. and Goodson, L. B.
Polymerized stearonitrile	2,125,851	8- 2-38	Ralston, A. W.
Triethanolamine reaction product with stearic or oleic acid.	2,018,758	10-29-35	Ellis, C.
Urethane	2,187,742	1-23-40	Johnson, J. W.
Phosphorus Compounds:			
Beta-amyl phenoxy ethyl phosphite	2,230,543	2- 4-41	Mikeska, L. A. and Nelson, J. F.
Dialkyl and diaryl dithiophosphoric acid derivatives.	2,343,831	3- 7-44	Osborne, J. L.
Diphosphorous esters	2,373,670	4-17-45	Engelke, E. F.
Lecithin and lanolin or sperm oil	2,212,020-1	8-20-40	Hendrey, W. B.
Phenyl 1.4-phosphoxane	2,160,915	6- 6-39	Schreiber, W.
Phosphine oxide or sulfide	2,138,835	12- 6-38	Butz, J. G.

TABLE 9 (Continued)
Oiliness Carriers and Related Additives

Substance	U.S. Patent	Date	Inventor
Phosphorus Compounds—Continued			
Phosphines which may or may not contain chlorine and sulfur.	2,260,303-5	10-28-41	Engelke, E. F.
Phosphites and abietic acid esters condensation products.	2,392,468	1- 8-46	Engelke, E. F.
Phosphoric acid esters	2,414,263	1-14-47	Kemp, L. C., Jr.
Phosphorized castor oil	2,294,817	9- 1-42	Van Dijck, W. J. D.
Phosphorised cracked petroleum residua.	2,359,979	10-10-44	Engelke, E. F.
Phosphorus acid ester and aroxyalkanol reaction product.	2,349,462	5-23-44	Reuter, R.
Phosphorus acid esters	2,315,544	11- 5-40	Reuter, R.
Tolylphosphite	2,220,851	11- 5-40	Schreiber
Trialkyl phosphates	2,340,331	2- 1-44	Knutson, A. T. and Graves, E. F.
Tricardanyl phosphate	2,389,513	11-20-45	Kemp, L. C., Jr.
Triethyl phosphite	2,294,804	9- 1-42	Ricketts, V. L.
Triphenylphosphine	2,149,271	3- 7-39	Buts, J. G.
Tripbenyl phosphite or phosphate and stearic acid.	2,203,102	6- 4-40	Powers, R. P.
Triphenylphosphite and propyl phenoxymethanol reaction product.	2,325,076	7-27-43	Reuter, R.
Tritolyl phosphate and an aliphatic ketone.	2,278,851	4- 7-42	Hillman, E. B.
Compounds of Sulfur and Halogens:			
Aryl sulfonyl chloride	2,232,649	2-18-41	Auer, L.
Chlorinated paraffin wax treated with a polysulfide.	2,124,598	7-26-38	Turner, L. B.
Chlorinated naphtha treated with an alkali alkyl thiocarbonate in the presence of acetone.	2,163,535	7-20-39	Berger, H. G., Moran, R. C. and Seger, F. J.
Chlorinated paraffin wax treated with sodium sulfide.	2,192,700	3- 5-40	Turner, L. B.
Chlorinated solvent extract and sodium mercaptide reaction product.	2,311,500	2-16-43	Zimmer, J. C. and McNulty, G. M.
Chlorobenzyl alkyl xanthates	2,422,769	6-24-47	Blake, E. S. and Godfrey, K. L.
Chlorobenzyl sulfide and methyl naphthenate.	2,417,088	3-11-47	Frutton, C. F.
Chloro-sulfurised paraffinic hydrocarbon and a solvent extract.	2,361,522	10-31-44	Zimmer, J. C. and McNulty, G. M.
Condensation product of an aromatic compound and chlorinated wax, and sulfur and chlorine compounds.	2,369,149	2-13-45	Lieber, E.
Dibenzyl disulfide and chlorinated wax or a halogenated ether or ester	2,208,161-3	7-16-40	Frutton, C. F., Smith, A. K. and Johnson, H. E.
Dibenzyl disulfide and chlorinated wax or chlorinated diphenyl ether.	2,322,209	6-22-43	Frutton, C. F.
Dibenzyl sulfide containing chlorine	2,153,482	4- 4-39	Frutton, C. F.
Ethanesulfonyl chloride	2,219,164	10-22-40	Moser, F. R. and Tuyn, M. C.
Halogenated naphtha and alkali thiocyanate reaction product.	2,202,641	5-28-40	Badertscher, D. E., Berger, H. G. and Seger, F. M.
Halogenated organic compound and sulfurised mineral oil.	2,204,620	7-18-40	Frutton, C. F. and Smith, A. K.
Halogenated thio-ether	2,213,988	9-10-40	Lincoln, B. H. and Henriksen, A.
Halogenated xylene and sulfur	2,396,223	3- 5-46	Frutton, C. F.
Isobutylene polymer containing chlorine and sulfur.	2,259,695	10-21-41	Hull, C. M.
Perchloromethyl mercaptan	2,228,252	1-14-40	Berger, H. G. Badertscher, D. E. and Seger, F. M.
Perchloromethylmercaptan and sulfur reaction product.	2,329,324	9-14-43	Berger, H. G. and Seger, F. M.
Perchloromethylmercaptan and lard or linseed oil reaction product.	2,197,781	4-23-40	Badertscher, D. E., Berger, H. G. and Seger, F. M.
Perchloromethylmercaptan reaction product with 2-pentane, lard oil, olive oils, cottonseed oil or linseed oil.	2,319,183	5-11-43	Badertscher, D. E., Seger, F. M. and Berger, H. G.
Reaction product of an organic halogen and sulfur compound.	2,347,217	4-24-44	Frutton, C. F. and Smith, A. K.
Sulfonyl fluoride of octylbenzene	2,337,432	12-21-43	Thomas, C. A.
Sulfur and chloronaphthalene	2,188,255	1-23-40	Steiner, W. L.
Sulfur chloride condensation product with hydrocarbons.	2,244,886	6-10-41	Lincoln, B. H. and Henriksen, A.
Sulphur chloride and isoolefin polymer reaction product.	2,320,312	5-25-43	Thomas, R. M. and Sparks, W. J.
Sulfur chloride and olefin reaction product.	2,249,312	7-15-41	Kimball, R. H.
Sulfur chloride reaction product with a solvent extract.	2,227,952	1- 7-41	Zimmer, J. C.
Sulfurised halogenated naphtha and an auto-condensation product of hydroxyarylalkyl amine.	2,340,036	1-25-44	Zimmer, J. C. and McNulty, G. M.
Tetrachlorodiphenyl sulfide	2,172,954	9-12-39	Clark, F. M.
Trichlorobenzyl butyltrithiocenecarbonate.	2,396,487	3-12-46	Blake, E. S.
Compounds of Sulfur and Nitrogen:			
Aliphatic amine thiocyanate	2,362,890	11-14-44	Dietrich, M. A.
Dodecene dithiocyanate	2,169,700	8-15-39	Loane, C. M. and Shoemaker, B. H.
Heptadecylthioamide	2,168,848	8- 8-39	Ralston, A. W.
Nitrothiophene	2,192,930	3-12-40	Panagiotakos, P. C.
para-Toluenesulfonhydroxamic acid	2,279,560	4-14-42	Dietrich, M. A.
Phenol isothioeyanate and a hydrocarbon isothiocyanic ester	2,209,440	7-30-40	Adams, E. W. and McNulty, G. M.
Phenyl-alpha-naphthyl-alpha-nitrobenzene sulfinamide.	2,244,075	6- 3-41	Mikeska, L. A.
Sulfur-Naphthalene and an aromatic amine.	2,215,432	9-17-40	Swinehart, C. F.

Substance	U.S. Patent	Date	Inventor
Compounds of Halogens and Nitrogen			
Acids containing a nitrile group and chlorine.	2,300,291	10-27-42	Jolly, S. E.
Btucine dichlorostearate or stearate	2,224,366	12-10-40	Musselman, J. M. and Lankelma, U. P.
Halogenated amides of aliphatic acids.	1,959,054	5-15-34	Henriksen, A. and Lincoln, B. H.
Quinone chloroimine	2,367,344	1-16-45	Evans, E. A.
Triamylammonium chloroacetate	2,228,325	1-14-41	Olin, J. F. and Gosborn, R. H.
Compounds of Sulfur and Phosphorus:			
Condensation product of butylene and phenol treated with phosphorus sulfide.	2,169,634	8-15-39	Cantrell, T. L. and Turner, J. O.
Mixed anhydrides of an alkyl thiocarbonic acid and an acid of phosphorus obtained by the reaction of phosphorus trichloride with an alkali ethyl xanthate.	2,226,420	12-24-40	Badertscher, D. E., Seger, F. M. and James, W. H.
Paraffin wax treated with chlorine and phosphorus and sulfurised fatty oil.	2,405,482	8- 6-46	Zimmer, J. C. and Morway, A. J.
Phosphorus and sulfur incorporated into a condensation product of phenol and olefins.	2,226,334-6	12-24-40	Cantrell, T. L. and Turner, J. O.
Phosphorus pentasulfide	2,235,161	3-18-41	Morway, A. J. and Zimmer, J. C.
Phosphorus pentasulfide reaction product with a fatty acid ester.	2,399,243	4-30-46	Musselman, J. M.
Sulfurised and phosphorised fatty oil.	2,274,025	2-24-42	Yule, J. A.
Sulfurised lard oil and phosphorus	2,211,306	8-13-40	Whittier, W. A., Williams, N. D. and Moire, H. L.
Sulfurised and phosphorised lard oil	2,382,121	8-14-45	Whittier, W. A.
Sulfurised and phosphorised lard oil, Twitchell reagent and diethylene glycol.	2,211,250	8-13-40	Anderson, P. T. and Moir, H. L.
Triaryl trithiophosphite	2,188,943	2- 6-40	Evers, W. L.
Tripbenyl or triamyl thiophosphate	2,157,452	5- 9-39	Humphreys, R. L.
Tritolyl dithio phosphate	2,263,618	11-25-41	Downing, F. B., Benning, A. F. and Johnson, F.W.
Compounds of Chlorine and Phosphorus:			
Amyl benzene dichlorophosphine	2,276,492	3-17-42	Jolly, S. E. and Perrine, J. H.
Chlorinated tritolyl phosphate	2,289,509	7-14-42	Malisoff, W. M.
Esters of acids of phosphorus and ethylene dichloride.	2,236,915	4- 1-41	Morton, F.
Halogenated lecithin	2,166,286	7-18-39	Denham, B. B.
Mineral wax and a phosphorus and halogen compound.	2,252,674	8-12-41	Frutton, C. F.
Phosphorised lard oil and heptachloropropane.	2,254,337	9- 2-41	Whittier, W. A.
Phosphorus chloride and trimethyl citrate.	2,252,675	8-12-41	Frutton, C. F., Smith, A. K. and Frey, D. R.
Phosphorus trichloride reacted with a partially hydrogenated rosin.	2,262,813	11-18-41	Morway, A. J. and Zimmer, J. C.
Propyl or butyl benzene dichlorophosphine.	2,190,715	2-20-40	Jolly, S. E. and Perrine, J. H.
Compounds of Phosphorus and Nitrogen:			
Tribenzylphosphazine	2,302,703	11-25-42	Lincoln, B. H. and Byrkit, G. D.
Compounds of Sulfur, Halogens and Nitrogen:			
Chlorinated octyl cyanide and sulfurised methyl oleate.	2,353,169-70	7-11-44	Lincoln, B. H. and Steiner, W. L.
Reaction product of sulfur chloride and an aliphatic nitrile.	2,141,142	12-20-38	Ralston, A. W.
Compounds of Sulphur, Halogens and Phosphorus:			
Chlorophenyl or chlorobenzyl thiophosphate.	2,242,260	5-20-41	Frutton, C. F.
Compounds containing a phosphorus halide radical and sulfur or oxygen.	2,223,793	12- 3-40	Peery, N. E.
Reaction product of lard oil, sulfur chloride and phosphorus trioxide.	2,352,818	7- 4-44	Whittier, W. A. and Stucker, J. B.
Reaction product of lard oil, sulfur halide and phosphorus.	2,274,022	2-24-42	Williams, N. D.
Reaction product of lard oil, sulfur halide and a phosphorus compound.	2,268,232	12-30-41	Whittier, W. A.
Sulfophosphasobenzene chloride	2,339,710	1-18-44	Lincoln, B. H. and Byrkit, G. D.
Tris (dichloroxylyl) thiophosphate	2,353,106	8- 8-44	Frutton, C. F.
Compounds of Sulfur, Phosphorus and Nitrogen:			
Reaction product of phosphorus pentasulfide and an aromatic amine.	2,403,894	7- 9-46	Bartlesen, J. D.
Sulfurised and phosphorised acid amide.	2,348,044	5- 2-44	Whittier, W. A. and Stucker, J. B.
Compounds of Phosphorus, Halogens and Nitrogen:			
Phosphenasobenzene chloride	2,380,454	7-31-45	Lincoln, B. H. and Byrkit, G. D.
Reaction product of an aliphatic amine with phosphorus trichloride, oxychloride, tri or penta sulfide, or chlorosulfide.	2,146,584	2- 7-39	Lipkin, D.

stances which are used in boundary lubrication.

The straight mineral oils may be assumed to possess approximately the same degree of oiliness irrespective of the nature of the crude from which they arise or of the treating methods employed in their manufacture. Evans[2] found that practically all mineral oils have a film rupture strength of 4000-5000 psi, which is more than sufficient for all practical purposes, including motor lubrication, because in well lubricated bearings the loads rarely exceed 2000 psi, and the rubbing speeds are high enough to maintain a constant film of oil between the bearing and the journal. However, when loads are very high such as in engines during the break-in period or in some of the industrial machinery it may be desirable to improve the performance of lubricating oils by the addition of special oiliness carriers.

A large number of substances has been proposed for improving oiliness of lubricating oils. Their proper classification presents considerable difficulties, particularly because some of them possess a chemical structure which suggests that their action may be attributed to causes other than those which could be explained by the prevalent lubrication theories. The differentiation between the oiliness carriers and extreme pressure agents is likewise not always possible and in many instances may depend not on the nature of the substance but on the quantity used.

The oiliness carriers usually have more or less pronounced acidic properties and contain oxygen, sulfur, halogens and similar elements in their molecule. This can be expected because substances capable of maintaining a tenacious film around the metal surface should possess a certain affinity towards the metal without being unduly corrosive. At the same time the high pressure lubricants are usually moderately corrosive so as to insure an actual chemical effect on the metal surfaces in order to maintain their smoothness. Assuming that the rubbing surfaces may become slightly injured, high temperature would develop at certain protruding portions of the metal increasing the rate of chemical reactions and thus smoothening up the surface.

The list of substances recommended in the patent literature for decreasing friction between the rubbing surfaces is given in Table 9. Some of them are multifunctional or intended for certain particular uses, such as for cutting oils. However, they are all illustrative of the different types of compounds suggested for this purpose.

TABLE 10
Properties of Santopoids

PROPERTY	Santopoid S	Santopoid S-R1
Specific Gravity	1.15—1.20	1.15—1.20
Flash Point, °F.	250	250
Pour Point, °F.	—35	—35
SUV at 100° F.	265—340	300—375
Color	Dark Brown	Dark Brown
Sulfur, percent	10—15	10—12
Chlorine, percent	30—15	29—33

The use of oiliness carriers in petroleum oils may be traced almost to the beginning of the oil industry as shown by the dates of the older patents. Sulfur, fatty oils and similar materials were employed although the mechanism of their action was very little understood. The problem was attacked with renewed interest some thirty years ago when the lubrication problems acquired particular importance with the rapid advances in the design of modern machinery. This work is continued by many petroleum companies and scientific institutions leading towards further elucidation of the involved phenomena.

Typical commercial products are represented by Santolube 31, Santopoids, Vistone, Parapoid, Lubrizols and others.

Santolube 31 is a phosphite ester of alkylated phenol. It is a lightly colored viscous liquid or crystalline solid having a melting point of 120-130° F. and weighing 8.6 pounds per gallon. It is added to oils to improve their oiliness, film strength and oxidation resistance in quantities ranging from 0.25 to 1.0 percent but seldom exceeding 0.5 percent.

Santopoid S and Santopoid S-R1 are chlorine-sulfur type gear lubricants. Both have the same composition with the exception that Santopoid S-R1 contains a rust inhibitor. They are used in quantities as high as ten percent but usually 7.5 percent or less are sufficient for obtaining the desired improvement. Properties of these additives are shown in Table 10.

Vistone B is another example of an oiliness carrier and a film-strength improver. It is an oxygenated organic derivative containing a polar group. It is a non-viscous pale liquid having a 28.5° API gravity, a 340° F. flash point, a Saybolt Universal viscosity of 45 seconds at 100° F., a pourpoint of 0° F., a neutralization number of 0.3 and saponification number of 170. Its uses are similar to those of Santolube 31 and it is recommended for "break-in" oils and other applications. It is added to the oil in quantities of about 1-2 percent.

Parapoid 10-C is an extreme pressure lubricant similar to Santopoid S. It contains about 29.4 percent chlorine and 5.8 percent sulfur. It has a flash point of 260° F., Saybolt Universal Viscosity of 60 seconds at 210° F. and weighs 9.27 pounds per gallon at 60° F. It is added to the oils in about the same amounts as Santapoid S.

Lubrizol additives are employed for similar purposes. Lubrizol 702 is recommended in quantities of about 2½ percent for the "break-in" oils. Lubrizol 714 is suggested for motor oils in amounts varying from 2 to 3 percent. Lubrizol 745 is recommended for oils which have to withstand heavy conditions of service including the "break-in" oils and is a general purpose additive. About 5 percent of it is used in oil blends. The Anglamol additives 77-X and 82 were developed for hypoid and other heavy duty gear lubricants. A number of similar addition agents are available and the above are listed merely as examples of these types of products.

Instead of adding oiliness carriers to the oil, suggestions were made to secure similar results by interreacting the oil with chemicals. Acids which are present in the unrefined oil usually possess some oiliness characteristics. Similar substances may be produced by oxidizing various petroleum products[3] or aliphatic hydrocarbons of mineral origin.[4] Similar results are claimed to be secured if oils are heated in the presence of aluminum hydroxide,[5] stearyl chloride,[6] sulfur followed by extraction with chlorex,[7] aluminum stearate and an alkyloamine,[8] aluminum chloride and a halogenated hydrocarbon,[9] aluminum stearate and triethanolamine,[10] naphthalene, nitrobenzene, rubber and dimethylaniline[11] and others. These treatments usually affect properties of oils other than oiliness, such as viscosity index or pourpoint, thus making their classification somewhat arbitrary. In many instances they were proposed for preparation of extreme pressure lubricants or for making products which are on the borderline of greases.

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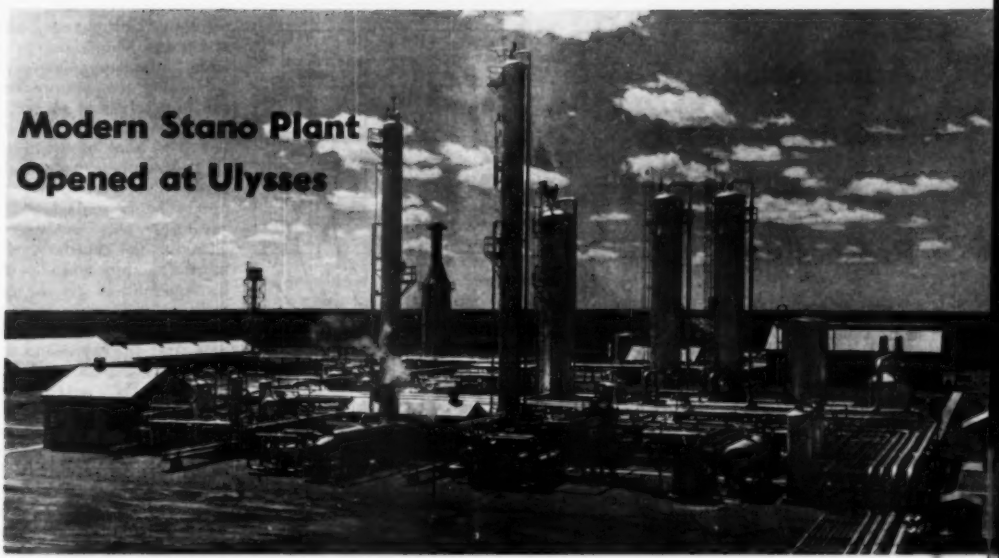
(Part IV will appear in an early issue.)

Modern Stano Plant Opened at Ulysses



General view of Stanolind Oil and Gas Company gasoline plant near Ulysses, Kan., as seen from top of cooling tower. Recompression house is left of process area, and generator house can be seen in right background. Elevated water tank and petrochem heater in left center background. Towers from left are depropanizer, debutanizer, still, two oil absorbers.

STANOLIND Oil and Gas Company held open house July 17 for the public at its Stano gasoline plant, 7 miles west of Ulysses, Kan. The plant, one of several new units being built by Stanolind and others as part of an expanding natural gasoline program, processes gas from the Hugoton field.

The Stano plant, a conventional absorption-type gasoline plant, is one of the newest of its kind and is 100 percent owned by Stanolind. First tests were made in February of this year, just a little more than 12 months after construction was begun.

Capacity of the plant is 100 million cubic feet of gas daily. When operating at this rate, Stano produces 26,600 gallons of natural gasoline and 36,600 gallons of liquefied petroleum gas every 24 hours.

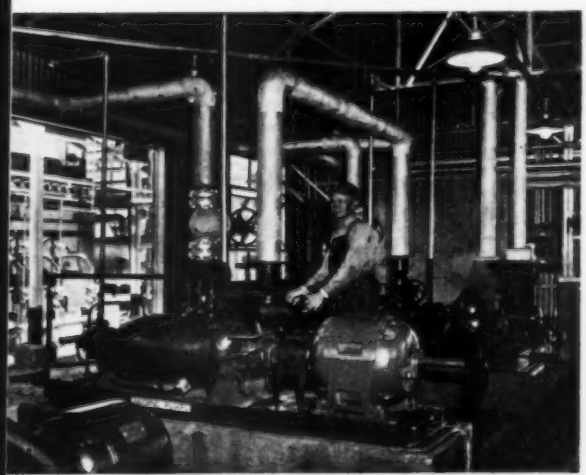
Absorbers operate at a pressure of 350 psi., which is maintained at the present time by the pressure of the field gas. If the field pressure drops appreciably, however, compressors will be installed to compress the gas up to operating pressure. About 265 wells are now connected to the plant, some of them nearly 30 miles away.

Electrical power needed by the plant and camp is supplied by three 500-kilowatt, 480-volt generators, driven by gas engines. Two generators furnish enough power to supply plant and camp needs, and the third is used as a stand-by.

Water comes from two deep wells on the plant site that have a total pumping capacity of 1500 gallons per minute. However, since a closed water circulating system is used, only a small part of this potential is needed for makeup.

Steam is generated in two water tube boilers with a capacity of 35,000 pounds of steam per hour.

C. J. Tighe is superintendent while other members of the Stano staff include D. M. Liles, plant foreman; L. E. Childers, operating engineer; W. J. Holder, plant clerk; H. U. Hawkins, plant electrician, and M. J. Sheridan, gang pusher.



Picture at left shows interior of boiler pump house at Stano's Ulysses plant. Picture at right is a view of the process area showing cooling tower and product storage tanks in background. Towers from left are two oil absorbers, still, debutanizer and depropanizer. Plant can handle as much as 100 million cubic feet daily.

Applications of Thermodynamics To Hydrocarbon Processing

PART XXI–EXPERIMENTAL VAPOR-LIQUID EQUILIBRIA METHODS AND EMPIRICAL CORRELATION OF DATA

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AS POINTED out in Part XX, a combination of experimental data and applied theoretical equations is one of the most promising methods of developing correlations for non-ideal K values of hydrocarbon systems. A procedure for calculating the vapor phase activity coefficients and then taking the experimental K values apart was also outlined in Part XX.

In this chapter the different experimental methods that have been used will be described and some of the available data will be discussed. The apparatus involved in these various methods are illustrated by sketches.

Developing complete and reliable activity coefficient correlations by this combination of theory equations and experimental data will take time and considerable effort. Until such a comprehensive correlation becomes available, the process engineer will probably use empirical correlations of experimental data with the necessary correction factors. An empirical correlation of this type is presented in this installment.

Experimental Methods

Vapor-liquid equilibrium data have been experimentally measured in many ways. It is of interest to discuss some of these methods and the type of data obtained. A general classification of experimental methods in terms of the type of apparatus as well as the type of data are given in Table 55.

In Types I and II mixtures of known composition are charged to the apparatus and the necessary observation made. From these data the vapor-liquid equilibria ratios are computed by graphical and other means. No samples of equilibrium vapor and liquid are taken and analyzed for composition in these cases. Type I is applicable only to binary systems, or to ternary systems if the mixtures studied are properly selected, while Type II may be applied to a mixture of three or more components. In both of these methods, there is considerable calculation work involved.

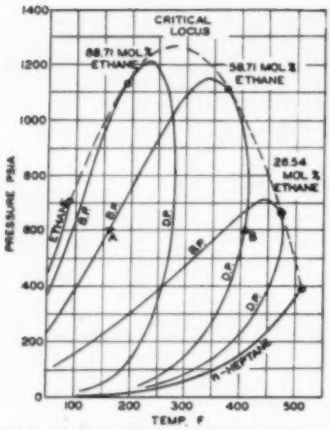

Figure 72. Phase Border T-Curves of Ethane-n-Heptane Mixtures. Source: Kay, Ind. Eng. Chem., 30, 459 (1938).

Kay[18, 19, 20, 22] has used Type I procedure in one type of apparatus while Sage and Lacey[27, 31, 32, 33, 34] have employed the same procedure with a different type apparatus. Both could have followed Type II procedure by measuring PVT data and working up the data by means of equations of state. Kay's apparatus consisted of a high pressure capillary tube in which the mixture could be stirred, while maintained under pressure at any of several temperatures. Pressure was maintained by mercury while temperature was maintained by the vapors from boiling organic compounds.

Holding temperature constant, the pressure is varied to get the mixture at the dew and bubble points, as identified by visual observations in Kay's case. Measurements of this kind are made for several compositions of the binary being studied at various temperatures. This involves periodically changing the capillary tubes containing the samples and also changing the heating fluid to get the desired composition and temperature range.

In these experiments the required data are: pressures and temperatures for the dew point and bubble point lines, i.e., PTX data in the form of a series of border curves. If the capillary tubes are calibrated, as they were for the work Kay did, and the amount of sample is accurately known, the specific volumes could also be measured. These volume data are not used in working up the data, however.

The method employed by Kay in working up the data is illustrated for the ethane-heptane system in Figures 72 and 73, which plots were redrawn from those given in Kay's[20] article. In Figure 72 the border curves for three of the binary systems studied are plotted along with the vapor pressure curves for pure ethane and n-heptane and the locus of the critical points for the system.

These border curves were then cross plotted, as shown in Figure 73, giving temperature-composition diagrams for different pressures. Only the TX diagrams for 200 and 600 psia. are shown but it is obvious that similar plots could be made for all pressures covered by the border curves in Figure 72. Points "A" and "B" on the 600 psia. saturated liquid and vapor lines of both plots illustrates this cross

TABLE 55
Experimental Methods for Vapor-Liquid Equilibrium Measurements

Type	Apparatus	Data
I	PT	Phase Border curves for Binary Systems
II	PVT	Volumetric behavior of mixtures of varying composition
III	Equilibrium Bomb	Composition of Equilibrium Vapor and Liquid Samples from Batch System
IV	Equilibrium Still	Composition of Equilibrium Vapor and Liquid Samples from Recirculating System with continual remixing and Separation
V	Equilibrium Separator	Composition of Equilibrium Vapor and Liquid Samples from once thru flow system

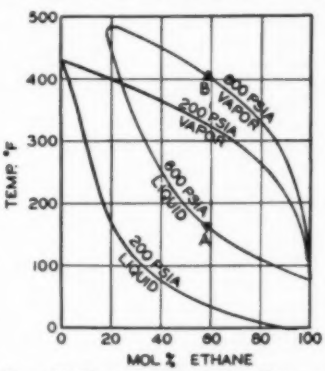

Figure 73. Temperature-Composition Diagrams Derived for Ethane-n-Heptane from Phase Diagrams in Figure 72. Source: Kay, Ind. Eng. Chem., 30, 459 (1938).

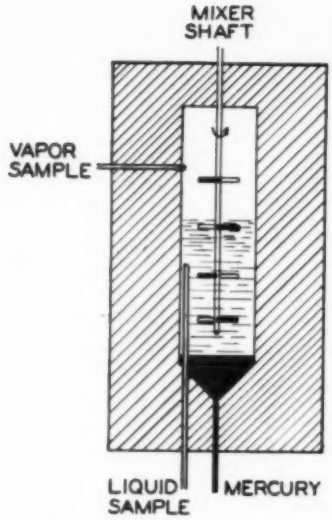

Figure 74. Stirred Equilibrium Bomb. Reference: Katz & Hackmuth, Ind. Eng. Chem., **29**, 1072 (1937).

plotting operation.

From plots like Figure 73 the K values of ethane and n-heptane may be found as follows:

At 600 psia. and 300° F

$$K_{ethane} = \frac{0.86}{0.33} = 2.6$$

$$K_{n\text{-}heptane} = \frac{1.0 - 0.86}{1.0 - 0.33} = 0.209$$

By this method Kay has produced a great deal of valuable binary equilibrium data for hydrocarbons. The same apparatus and experimental technique may be used to get the border curves for multicomponent system but such data cannot be analyzed in the manner illustrated in Figures 72 and 73 to obtain K values.

Complete PVT data may be obtained for multicomponent systems, however, and the equilibrium ratios derived by the partial molal volume route. Sage and Lacey[30, 31, 32, 33, 34] have employed this method, which is called Type II in Table 55.

In Types III, IV, V (Table 55) mixtures with co-existing vapor and liquid phases are brought to equilibrium and samples of the equilibrium vapor and liquid taken and analyzed for composition. From these composition data the values of the equilibrium vaporization ratio are computed as $K_i = y_i/x_i$ for each component. This method requires precise analyses but may be applied to systems of any number of components.

The three types of this experiment listed cover three different ways of obtaining these equilibrium vapor and liquid samples. Examples of the apparatus are shown in Figures 74 through 79, which show only the pertinent apparatus in a general way, no attempt being made to give details. The auxiliaries and details necessary to carry out the work have been omitted for simplicity in copying these drawings from the technical literature. It should be pointed out that these are representative and do not cover all the apparatus of this kind that has been used.

Figures 74, 75 and 76 represent three different equilibrium bombs that have been used in experimental vapor-liquid equilibrium work. In each of these bombs the object is to establish equilibrium and then take samples without any change in pressure or temperature. Temperature is maintained in all cases by the customary thermostat, the details of which are omitted. Pressure is maintained in Figure 74 and Figure 75 by means of mercury displacement.

In Figure 76 equilibrium vapor and liquid samples are obtained by isolating part of the vapor and part of the liquid in separate containers. In Figure 74 vapor and liquid samples are removed through separate connections. During this sample removal the mercury level is raised to keep the pressure constant. In Figure 75 both samples are removed through the same connection, the vapor coming out first and the liquid next, while the mercury level is raised to maintain pressure. The sampling in Figure 76 is intimately related to the establishment of equilibrium and will be described in that connection.

Equilibrium is established in Figure 74 by a stirred mixer, while the bomb is rocked on a pivot in Figure 76. In Figure 76 the equilibrium separator and the vapor and liquid sampling chambers are all rocked, after the sample has been charged and the connecting valves opened. In a horizontal position, as shown, the upper sample chamber will contain the equilibrium vapor while the lower sample chamber will contain the equilibrium liquid. By closing the valves to isolate the sample chambers, it is possible to remove the samples for analysis without disturbing the equilibrium.

Equilibrium bombs of the type illustrated by Figures 74, 75 and 76 have been used by Katz and Hachmuth,[17] Benedict et al.,[1] and by Boomer et al.,[3] respectively. These figures are simplified drawings of the figures presented by these authors.

The fourth type of vapor-liquid experiment listed in Table 55 is the equilibrium still wherein the mixture is distilled, condensed and recirculated to the still. After a period of operation equilibrium is established. This method was proposed by Othmer in 1928 and in later articles.[28] Modifications have been made by other authors.[12, 35] Figures 77 and 78 are two examples of the equilibrium still.

Othmer described, in 1928, a convenient low pressure equilibrium still

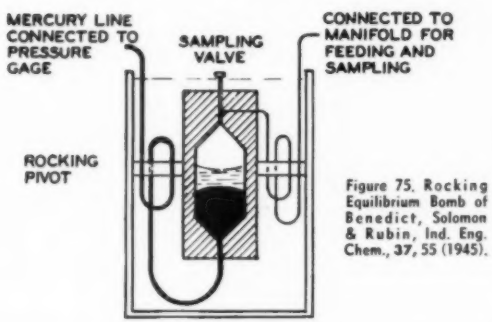

Figure 75. Rocking Equilibrium Bomb of Benedict, Solomon & Rubin, Ind. Eng. Chem., **37**, 55 (1945).

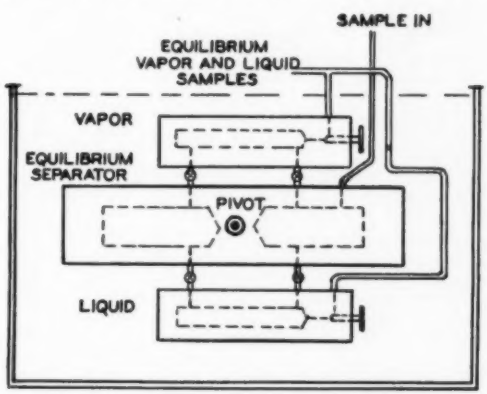

Figure 76. Rocking Equilibrium Bomb of Boomer, Johnson and Argue, Can. Jour. of Research, **15**, 367 (1937).

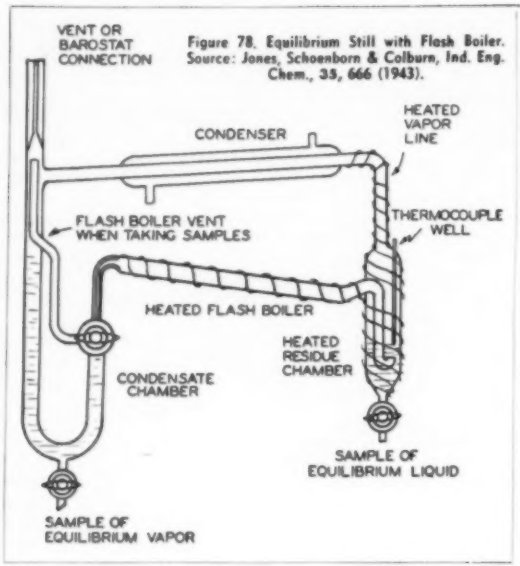

Figure 78. Equilibrium Still with Flash Boiler. Source: Jones, Schoenborn & Colburn, Ind. Eng. Chem., 35, 666 (1943).

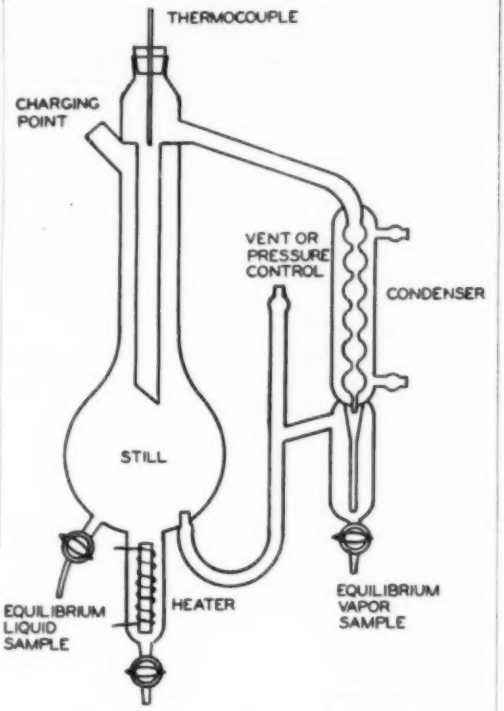

Figure 77. Othmer Equilibrium Still. Source: Othmer, Ind. Eng. Chem., 33, 614 (1943).

made of glass. One version of this still is illustrated in Figure 77. The mixture is charged to this still and circulation maintained by alternate vaporization and condensation until steady conditions are reached. Then vapor and liquid samples are taken. This apparatus depends upon the densities of the liquid and vapor phases for circulation. For high pressures changes must be made to avoid entrainment and to maintain circulation.

Scheeline and Gilliland[35] and Griswold et al.[12] modified this apparatus for high pressure operation, allowing ample space in still to avoid entrainment and providing enough head to insure return of the condensate to the still. The apparatus of Scheeline and Gilliland was made of glass, as was Othmer's. Griswold made his apparatus of steel.

A recent vapor-liquid equilibrium still, developed by Jones, Schoenborn and Colburn,[16] employs a flash boiler to revaporize the condensate, which is remixed with the residue by bubbling in through the residue. This still is shown in Figure 78. For a description of this apparatus and its operation, the reader is referred to the author's article.

Another technique used where there is an abundant supply of sample is that given in Table 55 as Type V. In this method the mixture is heated under pressure and throttled into an equilibrium separator where the equilibrium vapor and liquid are separated with no entrainment of liquid in the vapor and with no cooling or heating to cause departure from equilibrium. Vapor and liquid samples are taken and analyzed. The equilibrium separator used in this work is illustrated by Figure 79, which was copied from the drawing of the apparatus used by White and Brown.[38] The item shown in Figure 79 is only a small part of the total equipment required.

Type V method is used in making equilibrium vaporization runs on petroleum fractions. This subject will be covered in later installments.

Experimental Data

The literature listed at the end of this installment refers to much of the experimental work that has been done on vapor-liquid equilibrium in hydrocarbon systems. It will not be possible to discuss all this work and the data presented. A few comments will be made, however.

The data of Kay[19,20,22] are for the binary systems indicated and are derived from border curves, as illustrated in Figures 72 and 73. The binary data of Boomer, Johnson et al.[3] were methane with three different other hydrocarbons and were obtained in the apparatus as shown in Figure 76.

Sage and Lacey et al.[2,7,27,30,31,32,33,34] covered binary and ternary systems and also gave systems containing methane special attention, obtaining K values from a graphical work up of the border curves.

McCurdy and Katz[25] also obtained vapor-liquid equilibrium data by the border curve method, their binary systems being acetylene with propane and with propylene.

Stutzman and Brown[4,36] obtained vapor-liquid equilibrium data for light gases (nitrogen, methane, ethane) at low temperatures by a flow type experiment, putting natural gas through an equilibrium separator, similar to the one shown in Figure 79.

Katz and Hachmuth[17] obtained vapor-liquid equilibrium data for the components of a natural gas-crude oil system, using a stirred equilibrium bomb (see Figure 74). These data cover a wide range of pressures for paraffin hydrocarbons in crude oil at temperatures encountered in oil production.

Using a rocking equilibrium bomb made of two Jerguson gages and employing the mercury displacement sampling technique, Hanson and Brown[15] obtained K values for two paraffin hydrocarbon systems, containing methane, ethane, propane, n-butane, n-pentane and n-hexane at 100°F. and pressures between 500 and 1800 psia.

Two studies of equilibrium constants of hydrocarbons in absorption oil are included in the references. Kirkbride and Bertetti[21] employed an apparatus

containing an absorber, thermostat and an equilibrium bomb on high pressure gas with three types of lean oil. The apparatus, with oil in the absorber, was taken to the field where it was connected to high pressure gas and samples of equilibrium vapor and liquid were taken for analysis. The equilibrium bomb operated on the same principle as the one shown in Figure 76. The hydrocarbons covered were methane, ethane, propane, n-butane and n-pentane. Paraffinic, naphthenic and aromatic lean oils were used. Pressures from 800 to 3000 psia. were used. Temperatures were atmospheric.

Webber[37] also obtained equilibrium constants for light hydrocarbons in an absorption oil, using a rocking equilibrium bomb of the type shown in Figure 75. This work covered methane through n-hexane at temperatures of 33°, 100° and 180° F. and pressures from 115 to 5000 psia.

Gilliland and Scheeline[10,35] obtained data on the binary systems: propylene-isobutane, propane-hydrogen sulfide, and propane-isobutylene by means of an equilibrium still designed to operate under pressure.

Benedict, Solomon and Rubin[1] employed the rocking equilibrium bomb to determine the K value for the ternary methane-ethylene-isobutane system.

Drickamer, Brown and White[8] obtained vapor-liquid equilibrium data on phenol-hydrocarbon systems at atmospheric pressure, using both stills illustrated in Figures 77 and 78. Binary and ternary systems of the type encountered in phenol extraction of toluene were studied.

Griswold, Andres and Klein[11,12] obtained high pressure vapor-liquid equilibrium data for benzene-toulene by means of an equilibrium still.

Colburn et al.[6,9,16,26] have studied partially miscible mixtures by equilibrium still experiments. This work has been on hydrocarbon-furfural systems. Griswold, Klecka and West[13] studied liquid phase equilibrium for C_4 hydrocarbon-furfural-water systems.

Empirical Correlations of Experimental K Values

Because of the difficulty in taking experimental K values apart to get the liquid and vapor activity coefficients, it is customary to attempt an empirical correlation by plotting K values against temperature (or pressure) for lines of pressure (or temperature) in similar fashion to the methods used for ideal fugacity K values in Part XIX.

The problem encountered in this approach is that of obtaining smooth families of curves that fit all the data for a given hydrocarbon in different

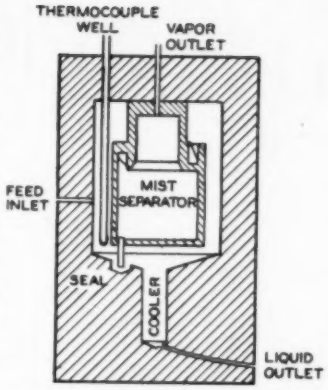

Figure 79. Equilibrium Separator used by White & Brown. Ind. Eng. Chem., 34, 1162 (1942).

systems (i.e. methane in ethane or in propane, etc.). To get around this difficulty smooth average curves are often drawn, compromising all the data, and then correction factors are obtained to apply with the smooth average charts so that the results will agree with the experimental values.

Most all experimentalists present empirical correlations of their own data when they publish their work. Usually authors compare their results with those of others, sometimes using plots. Less frequently authors of experimental papers will develop a correlation involving a comprehensive consideration of all available data as well as their own.

When made, correlation studies usually involve no experimental work and are often completely empirical with little theoretical basis. For these reasons there are usually gaps, limitations, or weaknesses to most empirical correlations of K values. In spite of this, these compilations are valuable design tools. A few empirical correlations will be discussed briefly.

An empirical correlation of equilibrium vaporization data was proposed by Kirkbride,[24] who correlated relative volatilities with ethane as the reference component. These correlations give the K values for ethane and the α values for 18 hydrocarbons, each (i.e., K and α) as a function of P and T.

A more recent correlation study of this kind was by Hadden[14] who developed three nomograph charts to give what he called "ideal" K values but what were in reality smoothed average experimental data. Two of these nomographs are for light hydrocarbons and one for heavy hydrocarbons. One of the light hydrocarbon charts is for temperatures below 0° F. and one for temperatures above zero.

Hadden Figure No.	Temp. (°F.)	Pressure (psia.)	Components
1	0 to 500	10 to 2000	Hydrogen through Decane
2	500 to 1000	5 to 1000	Methane through 1100° F. atm. av. B. P.
3	—200 to 0	10 to 1000	Hydrogen through n-pentane

These three nomographs are of Type I shown in Figure 70 in Part XIX, i.e., the two parallel main scales are of temperature and K values with the system pressure and the hydrocarbon located on a grid in between. As pointed out in Part XIX this type of nomograph has two disadvantages: (a) lack of reading precision, and (b) a separate straight edge setting is required for each K reading.

The temperature, pressure and component ranges covered by Hadden's nomograph are shown in the accompanying tabulation.

These three nomographs overlap in the components they cover, which is convenient. However, they do not overlap in temperatures covered. At times this is inconvenient.

Hydrogen appears on both Figures 1 and 3, but on different sides of the K scale, thus giving K values that decrease with increasing temperature above 0° F. (see Figure 1), while increasing with increasing temperature below 0° F. (see Figure 3). This negative temperature coefficient of the K vs. T relationship will be discussed in more detail later.

The direct readings from Hadden's Figures 1 and 3 for hydrogen at 0° F. are not in agreement as can be seen from two readings made for hydrogen at 0° F. and 500 psia., which give $K = 74$ from Figure 1 and $K = 29$ from Figure 3. Readings from the two charts for methane and heavier are in much better agreement, however. Comparing direct readings from these charts for hydrogen is not a true indication of the accuracy of Hadden's empirical correlation. A comparison of corrected K values would be more indicative.

Along with these nomographs, Hadden presents tables and charts giving correction factors to be used in computing K values from the direct chart readings. There are four graphs giving correction factors for methane, two graphs being for methane in binary mixtures and two for methane in complex mixtures. For the binary systems the correction factor is a function of the critical temperature of the heavier component and to a lesser degree of the system pressure and temperature. For the complex systems the correction factor for the methane K values

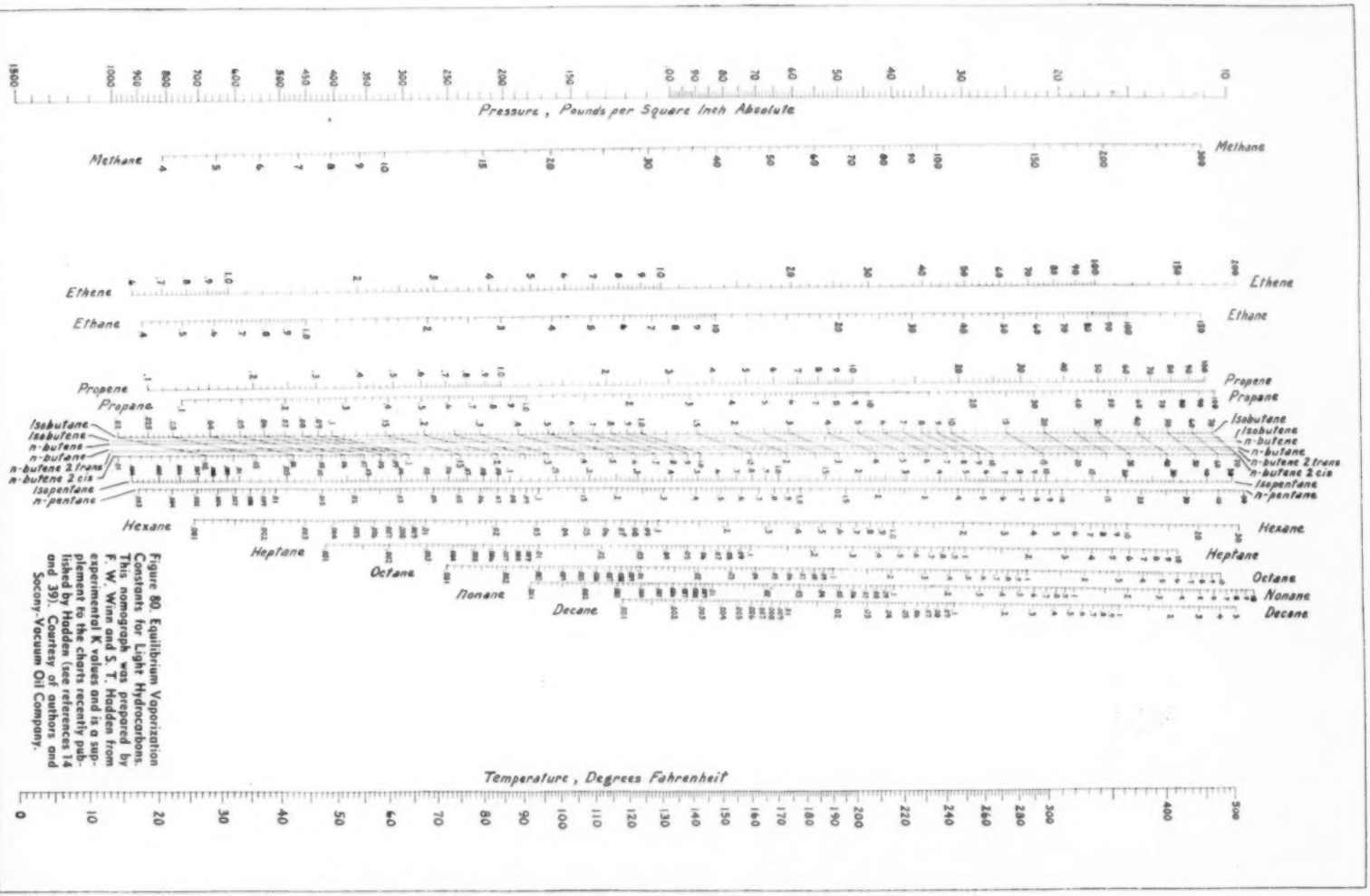

Figure 80. Equilibrium Vaporization Constants for Light Hydrocarbons. This nomograph was prepared by F. W. Winn and S. T. Hadden from experimental K values and is a supplement to the charts recently published by Hadden (see references 14 and 39). Courtesy of authors and Socony-Vacuum Oil Company.

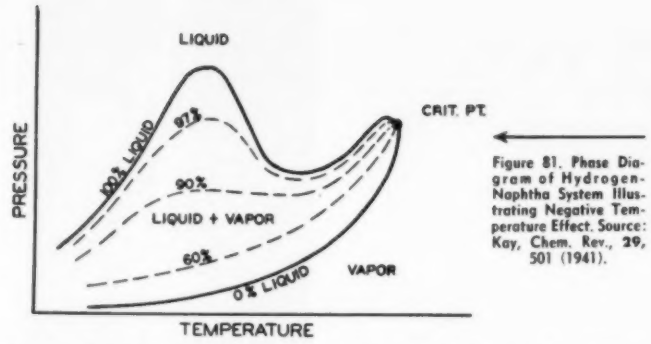

Figure 81. Phase Diagram of Hydrogen-Naphtha System Illustrating Negative Temperature Effect. Source: Kay, Chem. Rev., 29, 501 (1941).

is a function of the molecular weight of the heavy component and the system pressure.

Hadden also gives two tables of correction factors for hydrogen K values obtained by direct readings from Figures 1 and 3, the correction factors in one table applying to Figure 1 and those in the other applying to Figure 3. In this way the corrected readings from both nomographs are in agreement with observed values. The temperature and composition ranges covered by these two tables of hydrogen K correction factors do not overlap. The temperature ranges are 75 to 300° F. and —175 to —121° F., respectively, for the tabulations of correction factors offered for use with Figure 1 and Figure 3. The heavy components are C_4 through C_{12} and C_1 through C_2, respectively for these same tabulations.

Temperatures from —121 to 75° F. are not covered by the correction factors. Also no C_3 hydrocarbons are included. These omissions are due to lack of data and not any fault of Hadden. This uncovered area makes it impossible to compare corrected hydrogen K values from Figures 1 and 3 at the common temperature of 0°F. However, it should not be concluded that these two nomographs, with the recommended correction factors, do not give consistent and accurate K values for hydrogen. It would be more satisfactory if the two charts agreed at 0° F. and if the correction factors were more complete, however.

This hydrogen situation illustrates the difficulty that may be encountered in making empirical correlations of K values that depend upon over-all correction factors for fitting experimental values. Much of this difficulty could be avoided by developing separate activity coefficients for the vapor and liquid phases.

In the discussion of Hadden's article, the writer suggested using the Scheibel-Jenny scales, as illustrated by Figure 71 (Part XIX), in correlating the experimental K values. Winn and Hadden[39] have prepared such a nomograph, which is reproduced here as Figure 80, through the courtesy of Socony-Vacuum and the authors. The advantages of this chart are 1) a single straight edge setting for all the readings for a given system, and 2) greater reading precision.

The negative temperature coefficient of hydrogen, referred to in the above discussion of Hadden's nomographs, is explained by the phase diagram of a hydrogen-naphtha system prepared by Kay[21] and reproduced here as Figure 81. The hump in the liquid line results from the solubility characteristics peculiar to this mixture. Such a hump probably exists for other light gases under the proper conditions.

In the next installment the convergence pressure concept and the correction of K values for proximity to the critical will be discussed.

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(End of Part XXI. Part XXII will appear in an early issue).

National Tube Expands Research Activities

A BATTERY of 20 creep-testing machines recently was put in operation at the Research Laboratory of National Tube Company in Pittsburgh, the new facilities being part of the expansion program for research and production equipment in progress throughout United States Steel Corporation subsidiaries. The machines have been installed in a compact bank, complete with an auxiliary power supply, constant primary voltage control and complete instrumentation. The unit includes 18 lever type machines and 2 screw-driven machines, part of which is shown in **Figure 1.**

Creep-testing equipment of the most advanced design was purchased, and certain additional refinements were made to meet the laboratory's special requirements. Three thermocouples are attached to a specimen under test at the quarter and mid points, enabling an accurate check to be made on the temperature of the specimen at any time. Provision has been made for shielding all thermocouple wires. A separate power-control couple for each machine serves to maintain furnace temperature within plus or minus 2° F.

Furnace temperature records for the machines are maintained by three 6-point recorders which operate in conjunction with the controllers. The fact that the machines and instruments all operate in an air-conditioned room maintained at a constant temperature of 79° F. is of great help in maintaining consistent records as the problem of control is greatly simplified.

The lever-type machines are used primarily for creep-testing to predict the rate of stretch of specimens under load over long periods, at elevated temperatures, usually 10,000 to 100,000 hours, or for creep-rupture testing where failure of the specimen is anticipated within 1000 hours. All machines are equipped with electronically controlled, motor-driven extensometers as shown in **Figure 2.** These constantly follow the creep or stretch as it occurs, recording the extension on mechanical counters.

The two screw-driven machines, which are loaded through bar springs, are used primarily for short-time (24 hour) creep-rupture and high-temperature tensile tests. A two-point recorder maintains separate temperature records for the screw-driven machines. Both of these machines are equipped with specially designed autographic strain gages. These machines are shown on the left in **Figure 3.**

All the creep-test furnaces are capable of being maintained at 1800° F. for indefinite extended periods. One is capable of maintaining a temperature of 2600° F. All furnaces are at present interchangeable. Thermocouples are replaced after every test and each unit is checked before use in a standard constant-temperature furnace against a platinum-rhodium thermocouple calibrated by the U. S. Bureau of Standards.

Power for the creep-testing laboratory is ordinarily taken from the main 220-volt, 3-phase, 60-cycle power line through a constant voltage controller capable of regulating the current within plus or minus 1 percent.

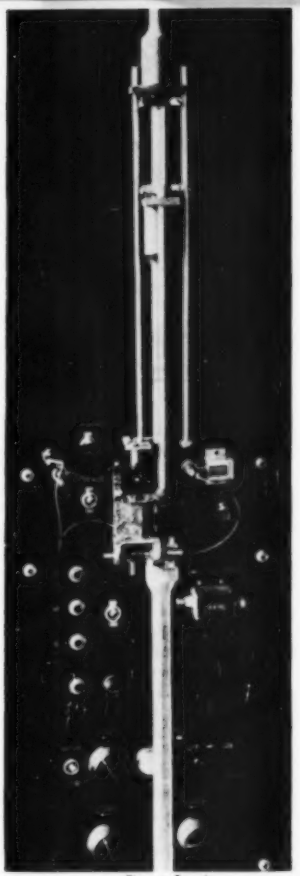


Figure 2

Figure 1

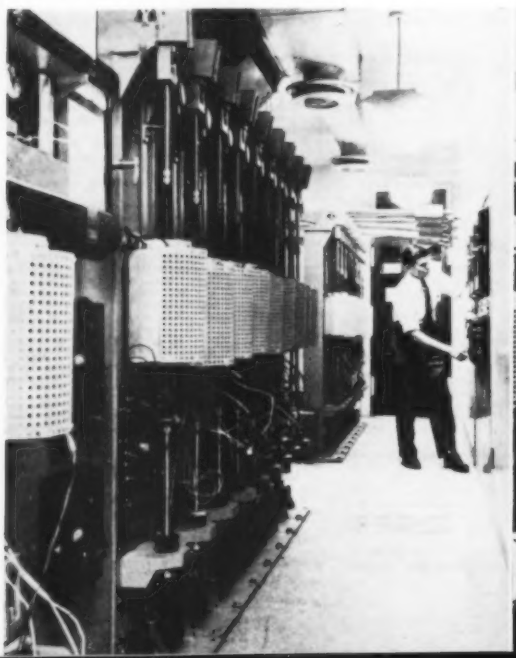
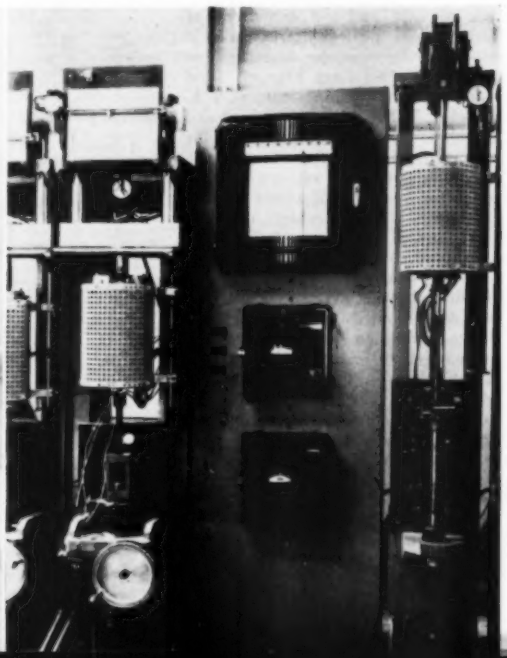


Figure 3



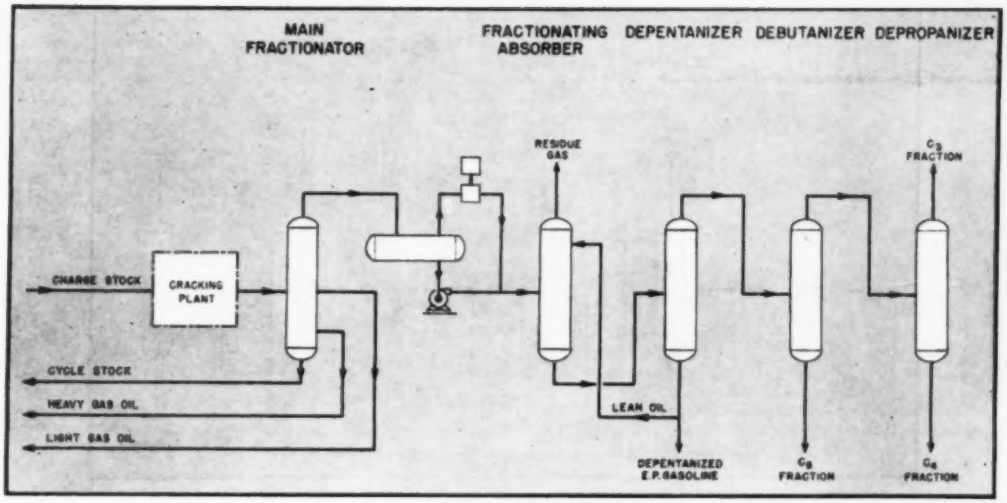


Figure 1. Cracked Products Recovery Unit

Fractionating Absorbers in The Petroleum Industry

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METHODS now in use in the petroleum industry for separating mixtures of low boiling hydrocarbons and associated compounds include: 1) fractionating absorbers, 2) low temperature fractionation and 3) adsorption methods.

These methods differ fundamentally in the manner of achieving a change of phase (and hence a change in the relative concentration of components). Outstanding examples of the application of each are:

1) Rich oil deethanization (i.e. separation of ethane and propane) in the natural gasoline industry.

2) Ethylene purification by low temperature fractionation in the chemical industry.

3) Hypersorption as developed by Union Oil Company and applied to propane recovery, ethylene purification, and similar problems.

Here will be discussed what we term "fractionating absorbers." Other terms commonly used are "rectified absorbers," "reboiled absorbers," and "absorber-strippers."

***RAPIDLY** changing conditions necessitate familiarity with all methods now in use in the petroleum industry for separating mixtures of low boiling hydrocarbons and associated compounds, this in order to obtain the most economic method for a given gas recovery and/or purification problem.*

The purpose of this article is to discuss one of these methods i.e., fractionating absorbers. Emphasis is directed toward application in the natural gasoline industry and to the design problems involved. A short cut method for calculating lean oil requirements is included and an example is shown of application to actual plant data.

A fractionating absorber may be defined as a fractionating column in which reflux is generated by means of an absorption medium. The top product of the components being fractionated is not at its dew point under column conditions. (The actual top product is at its dew point due to the small amount of lean oil vaporized.)

As in any fractionating device, it is necessary to increase the amount of material being recycled within the column in order to increase the separation achieved. In a regular fractionating column this can be done by merely increasing the amount of reflux pumped, revaporizing this in the reboiler and recondensing in the reflux condenser. In a fractionating absorber, the reflux must be dissolved in the absorption medium and the reflux amount can only be increased by an increase in either the amount of lean oil flowing or by increasing the amount of reflux absorbed per unit of lean oil. Consequently, the reflux cycle is set entirely by the amount of lean oil charged to the rectifying section and any cooling that is done in the rectifying section to increase the unit absorption.

Limited Heat Input

The practical result is that the heat input into the bottom of the column must be limited to the amount that can be handled by the rectifying section or desirable heavy components will be rejected with the column top product. In this respect, the lean oil may be considered analogous to the water stream removing heat from the con-

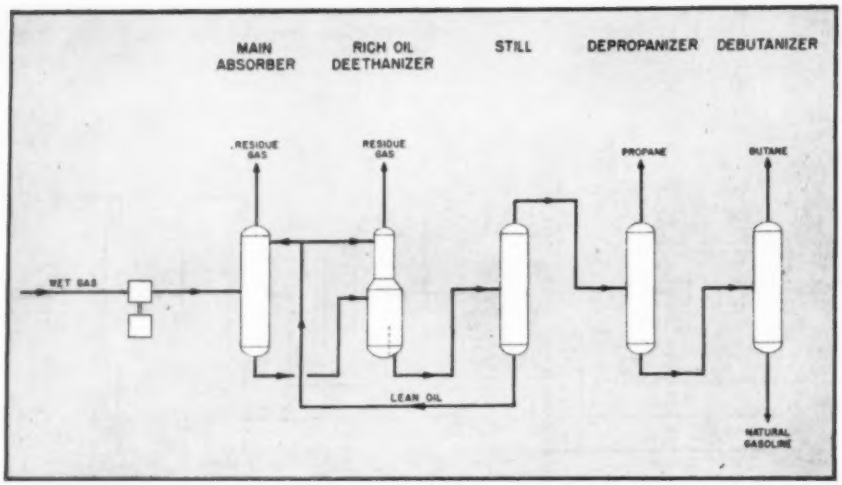


Figure 2. Natural Gasoline Plant Rich Oil Deethanizer Scheme

denser in a regular fractionating column.

In the petroleum industry, examples of the application of fractionating absorbers are found in cracking plant recovery systems and in natural gasoline plants.

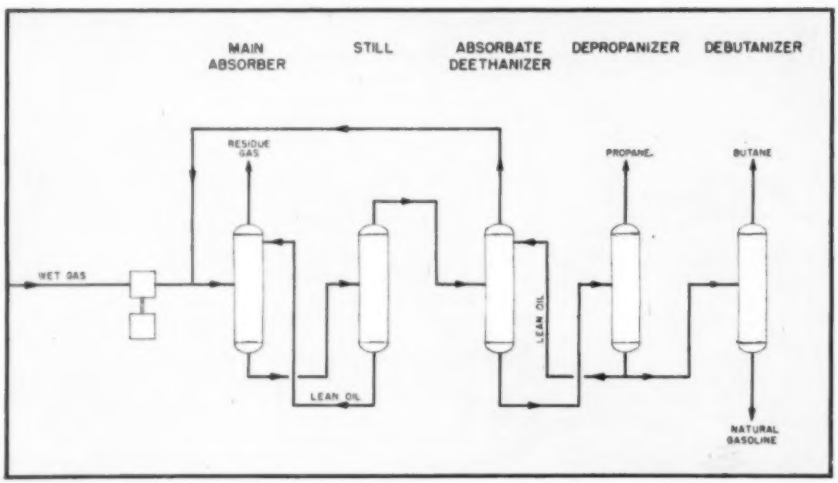
Application in Petroleum Refining

A typical flow diagram of a cracking plant recovery system using a fractionating absorber is shown in Figure 1. The cracking plant effluent is charged to a main fractionator on which the end point gasoline and all lower boiling components in the product are taken overhead. The liquid overhead is pumped and the gas compressed into a fractionating absorber. In this column, a separation is made between propylene and ethane. The lean oil used is depentanized gasoline from the bottom of the next column; this stream recycling through the two columns. Very high propylene recoveries with little ethane contamination can be obtained. The operation of these units is very satisfactory, the major problem being fouling of the deethanizing column with contaminants present in the feed.

Applications in the gasoline industry usually are for a deethanizing operation,[1] although demethanization is sometimes considered. Figures 2 and 3 show typical flow diagrams.

Deethanization is more difficult in the natural gasoline industry due to the greater proportion of ethane and lighter constituents present. Consequently, it is usually more economical to deethanize in a separate step rather than concurrently deethanizing and absorbing as in the cracking plant recovery system. This deethanization may be performed on the rich oil or on the absorbed constituents after they have been stripped from the lean oil. The first case is commonly termed "rich oil deethanization" and the second "absorbate deethanization." Rich oil deethanization is currently practiced in several operating plants. Absorbate deethanization has been pro-

Figure 3. Natural Gasoline Plant Absorbate Deethanizer Scheme.



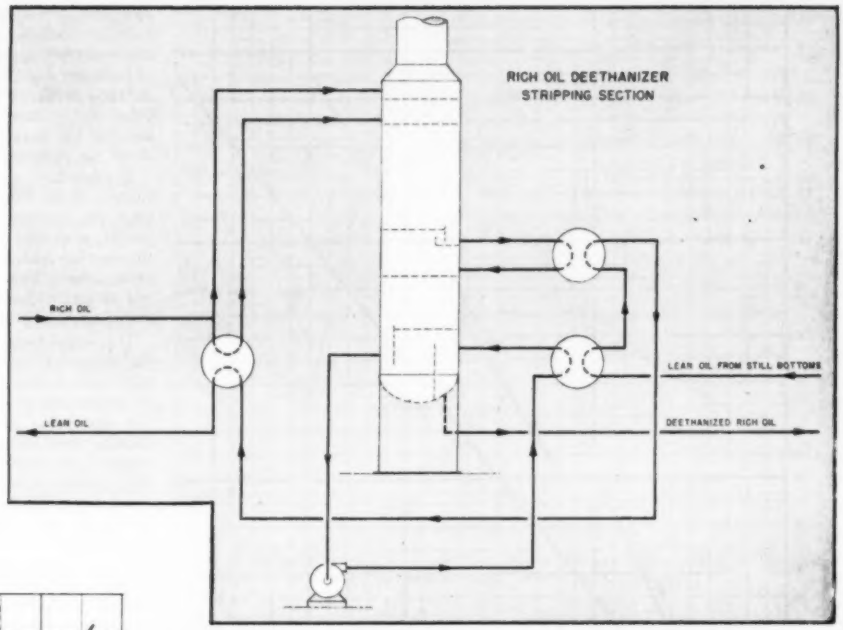


Figure 7. Heat Exchanger Set Up on Rich Oil Deethanizer

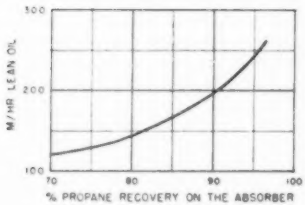


FIGURE NO 4
LEAN OIL RATE VS % PROPANE RECOVERY ON THE ABSORBER

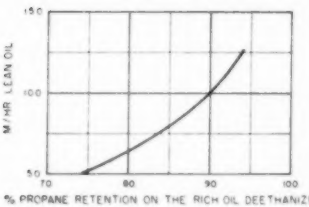


FIGURE NO 5
LEAN OIL RATE VS PROPANE RETENTION ON THE RICH OIL DEETHANIZER

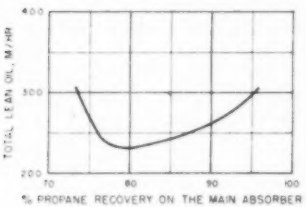


FIGURE NO 6
TOTAL PLANT LEAN OIL RATE VS % PROPANE RECOVERY ON THE ABSORBER FOR 70% OVERALL NET PROPANE RECOVERY

posed and shown to be competitive under certain conditions but never, to the author's knowledge, commercially applied. Absorbate deethanization can be used to increase propane retention in existing plants which are equipped with the conventional fractionating deethanizers. The lean oil (shown as required for the main absorber at three depropanized gasoline in Figure No. 3) reduces the amount of propane rejected from the deethanizer with the ethane and lighter constituents taken overhead. The overhead gas is recycled to the main absorber to recover the "heavy" constituents vaporized from the lean oil.

Problems involved in the design of rich oil deethanizing plants include: 1) establishing the optimum lean oil rate; 2) achieving optimum heat recovery and 3) control of the rich oil deethanizer.

The *optimum lean oil rate* is determined by calculating the lean oil different propane recoveries and then calculating the lean oil required for the rich oil deethanizer while maintaining the overall net propane recovery at the desired value. A curve of total lean oil required vs. the percent recovery on the main absorber can then be established showing the optimum lean oil rate. Figures 4, 5, and 6 are typical curves.

Optimum heat recovery is of course set by the value of fuel gas, the cost and availability of cooling water, and equipment maintenance and amortization. The temperatures of the lean oil to the coolers is often higher in rich oil deethanization gasoline plants than in other types. This fact is sometimes regarded by members of this industry as an indication that heat economy is poorer than in other schemes. This is not generally true, as often a lower quantity of lean oil is circulated for a given net propane recovery in rich oil deethanization schemes. However, better heat recovery and/or lower heat exchanger surface are achieved by using feed preheaters and side reboilers on these columns. Figure 7 illustrates the arrangement of this equipment and Figure 8 depicts the typical temperature difference relationship.

It is usually not economical to put more than about 30 percent of the total heat input into the feed preheater and side reboiler.

Another approach to increasing heat recovery is to reduce the bottom temperature of the *rich oil deethanizer* to improve heat transfer relationships. In general, the bottom temperature is a function of the composition of the wet gas being handled, the conditions under which the main absorber and rich oil deethanizer operate, and the propane recovery. The bottom temperature can be decreased by recycling propane through the bottom of the tower or by utilizing steam stripping to reduce the hydrocarbon partial pressure. However, since the lean oil must be heated to a temperature level suitable for stripping in any case (thereby

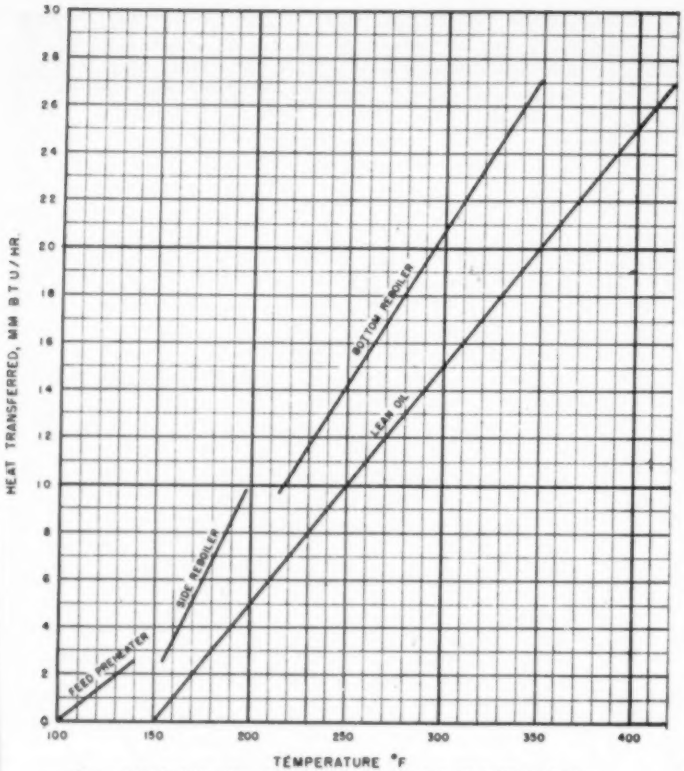


Figure 8. Typical Heat Transfer Relationships Around the Rich Oil Deethanizer

setting the heat exchange requirements), not too much gain can ordinarily be made in heat recovery by these means.

Satisfactory control of deethanizing in the rich oil deethanizer cannot be achieved by maintaining a constant bottom temperature. This is because the composition of the wet gas fed to the plant usually varies widely, due to changing separator conditions and to condensation and revaporization in the gathering lines. Figure 9 illustrates the temperature changes involved.

It should be possible to control deethanization at satisfactory levels by keeping the richness of the gas fed to the rectifying section at a proper level. The richness of this gas can be measured by a specific gravity controller or indirectly controlled by measuring the temperature rise of the lean oil in this section.

Proper control of this column performs the usual functions of 1) controlling propane vapor pressure, and 2) maintaining maximum propane recovery.

Design Method

Calculation methods for setting the lean oil rate and number of theoretical trays required include: 1) tray-by-tray methods; 2) combined absorption and tray-by-tray methods, and 3) absorption-stripping methods.

Tray-by-tray methods are generally accepted as the most rigorous design method available when heat balances are used, (eliminating the assumption of constant molal overflow). However, the time involved in making these calculations is considerable, and much thought has been given to developing short cut methods.

A procedure used with considerable success in the Fluor organization is to treat the *rectifying section as an absorber*, matching the required feed to this section with vapor from the stripping section. The stripping section vapor is established by tray-to-tray calculations, using heat balances.

It is considered necessary to handle the *stripping section* with tray-to-tray calculations since the large variations in temperatures and flow rates make the evaluation of effective stripping factors very difficult. Figure 10 illustrates these variations with data from tray-to-tray calculations. Kniel[2] indicates the difficulty of using stripping factors as he reports a calculated propane retention of 90 percent versus an actual recovery of 96 percent with better than calculated purity. This represents a tremendous difference between actual and calculated lean oil rates.

The author has attempted to develop short cut methods for setting the required lean oil rate in conjunction with the number of theoretical contacts in the rectifying or absorption section. This can be done very easily if the ratio of the two feed components in the total feed to the absorption section can be established. Several short cut methods for regular distillation column design assume that this ratio is the same in the total feed to the rectifying section as it is in the external

Nomenclature

D	ratio of recovery of the heavy key to the recovery of the light key in the rectifying section
A_t	absorption factor $= \frac{L}{VK}$ for the component designated
B	ratio of concentrations light key to heavy key in the feed vapor
C	hydrocarbon molecules—saturated
C″	hydrocarbon molecules—unsaturated
n	number of theoretical rectifying trays
R	fraction of the heavy key recovered in the rectifying section
V	moles/hr vapor
Y	mole fraction in the vapor phase
Z	moles/hr of heavy key fed to the rectifying section

Subscripts

hk	heavy key
lk	light key
D	top product or distillate
1,2, etc.	= no. carbon atoms in hydrocarbon molecule

vapor fed to the column (or the vapor that would be in equilibrium with the liquid fed to the column). These methods *usually* give good results. For cases where this assumption is valid, the lean oil rate required is calculated as follows: (See Figure 11 for the material balance envelope.)

1) Set n, the number of theoretical rectifying trays.

2) Select the key components, normally those adjacent to the cut point and critical to the separation.

3) Calculate the concentration of the key components in the feed vapor.

4) Set up the separation desired on the column.

5) Calculate the ratio of the light to the heavy key concentration in the feed vapor

$$B = \frac{(Y_{FV})_{lk}}{(Y_{FV})_{hk}}$$

6) Assuming that the feed tray vapor contains the key components in the same relative concentration that they appear in the feed vapor, set up the following equations relating the amount of the keys rejected from the column in the top product:

$$V_D(Y)_{hk} = Z(1 - R)$$

$$V_D(Y)_{lk} = B \times Z\left(1 - \frac{R}{D}\right)$$

7) Solve these equations for R, the fraction of the heavy key recovered in the rectifying section assuming that D equals the relative volatility of the two key components for the first trial. Use the absorption factor chart to relate the recovery of the two keys at the theoretical trays set in step 1. Repeat the calculation until D assumed is approximately equal to D calculated.

$$R = \frac{V_D(Y)_{lk} - V_D(Y)_{hk} \cdot B}{V_D(Y)_{lk} - \frac{V_D(Y)_{hk} \cdot B}{D}}$$

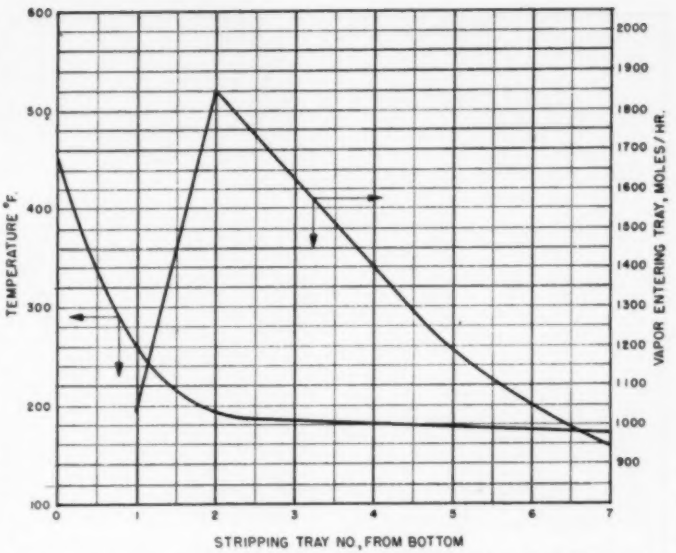


Figure 10. Variation in Temperature and Vapor Flow in Stripping Section of Rich Oil Deethanizer with a Side Reboiler—from Tray-by-Tray Calculations.

8) Now, knowing the average absorption factor required for the heavy key in the rectifying section, calculate the amount of lean oil required using regular absorber methods.

Example Given

An example of the application of this method is given at the end of this article. The basic assumption is apparently valid for this case since the tray efficiency calculated agree with other data available for similar absorbers.

This example is of a rich oil deethanizer. No temperature gradient information is available and the temperature selected is based on a knowledge of external conditions and typical temperature gradients. The calculated value of 17.5 percent for the tray efficiency is an excellent check for a lean oil MW of 197 and 12 characterization factor. Although not included in the data given, the absorber of this same plant indicated a tray efficiency of 15 percent based on propane recovery.

This method has also been applied to actual data taken on a cracking plant fractionating absorber. In this case, the actual temperature gradient was known and analyses of the liquid throughout the rectifying section were available. The tray efficiency calculated agreed for two different systems of key components and was also in good agreement with other data for similar absorbers.

Tray-by-tray calculations performed by the Fluor process group have shown that the lean oil requirements indicated by the short cut method can be appreciably reduced in some cases by increasing the number of stripping trays provided. The vapor leaving the stripping section can have a higher ratio of B than the external feed vapor due to a build-up of the light key component in the extra stripping trays used. The stripping tray efficiency

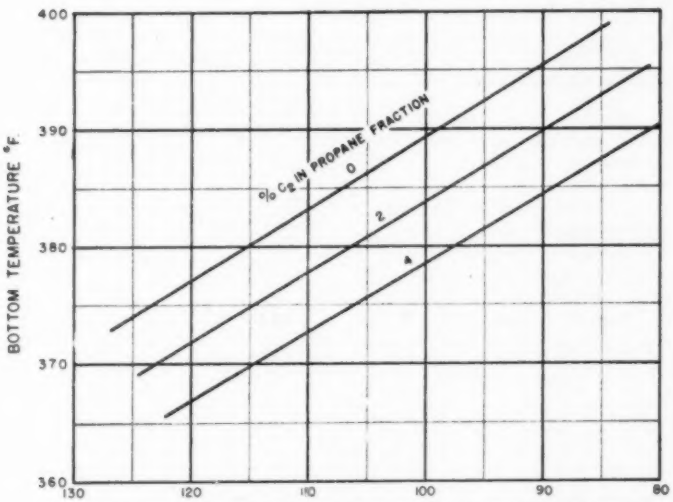


Figure 9. Variation in Bottom Temperature of Rich Oil Deethanizer with Gasoline Production at Constant Lean Oil Rates.

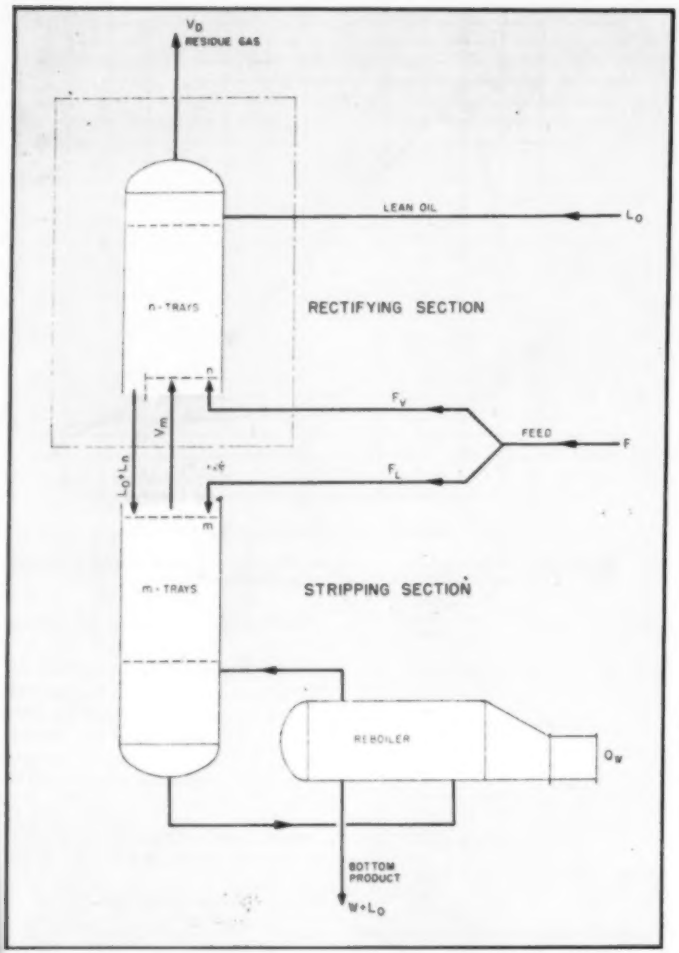


Figure 11

must be established from plant operating data.

Economics

The basic economy of the application of fractionating absorbers is evident from the increasing use of this device in the petroleum industry. First applications in the industry were made many years ago although the method was applied crudely due to the lack of experience and a simple, straightforward design method. Growing confidence in the use of design methods that do not entail high safety factors which nullify the margin of advantage over other schemes will lead to still wider application.

The author has not set up economic limits for the application of fractionating absorbers. Each case is worthy of separate consideration although past experience can serve to eliminate many non-competitive schemes. New developments, design ingenuity, special conditions, and equipment considerations can quickly destroy preformed concepts.

ACKNOWLEDGMENT

The author wishes to thank the management of the Fluor Corporation for permission to publish this paper and also wishes to acknowledge the efforts of members of the Process Department who have contributed much to the ideas and work forming the background for this article.

EXAMPLE

Natural Gasoline Plant Rich Oil Deethanizer

Material Balance: (excluding lean oil)

Component	Total Feed	Dry Gas (Tops)	Absorbed Gas (Bottoms)	Tops Percent Recovered
Air	1.5	1.5	....	....
CO_2	0.2	0.2	....	....
C_1	101.9	101.9	....	100
C_2	53.0	50.4	2.6	95.1
C_3	80.9	7.2	73.7	8.9
iC_4	24.5	0.1	24.4	0.4
nC_4	38.9	....	38.9	....
C_5+	33.2	....	33.2	....
Moles/hr.	334.1	161.3	172.8	....

Calculate the Tray Efficiency:

20 actual rectifying trays.
170 psia.
Av. temp. = 75° F.
Av. mole percent lean oil in liquid = 73
K values: $C_3 = 2.9$
$C_2 = 0.8$

Relative volatility of keys $= \frac{2.9}{0.8} = 3.62$

Actual lean oil rate = 111.3 moles/hr.

$$\text{av}\ \frac{L}{V} = \frac{111.3 \times 1.37}{161.3 + 0.37 \times 111.3} = \frac{152.5}{202.5} = 0.753$$

$$\text{Arc}_3 = \frac{0.753}{0.8} = 0.941$$

$$\text{Arc}_2 = \frac{0.753}{2.9} = 0.26$$

From flash calculations (feed is at its bubble point at 81° F. and 570 psia.) the ratio of the concentrations of the key components in the feed vapor, B, is 2.4 try 3.5 theoretical trays:

$$7.2 = Z(1 - R)$$

$$50.4 = 2.4\,Z\left(1 - \frac{R}{2.84}\right)$$

$$R = \frac{50.4 - 17.3}{50.4 - 6.1} = \frac{33.1}{44.3} = 0.748$$

Arc_3 required = 0.95

$$\text{Arc}_2 = \frac{0.95}{3.62} = 0.262$$

Actual ratio of recoveries $= \frac{0.748}{0.262}$
$= 2.85$ vs. 2.84 assumed

Therefore we have 3.5 theoretical trays and the tray efficiency $= \frac{3.5}{20} \times 100 =$ 17.5 percent.

Comments:

Although not shown in this example, the tray efficiency for the main absorber in this plant was calculated at 15 percent based on propane. This is an excellent check.

LITERATURE CITED

[1] Whistler, Oil and Gas Journal, Vol. 45, No. 25, Oct. 26, 1946.
[2] Kniel, Ludwig. Petroleum Refiner, November 1948.

* * *

Automotive Research Lab Now in Operation

Each automobile in the fleet of test cars at the new automobile research laboratory near Baltimore, Md., dedicated recently by American Oil Company and Pan American Refining Corporation is a moving laboratory. The complicated dashboard reveals the reaction of every part of the engine to the motor fuel under test. Smoother rides and more miles per gallon of gasoline are the goals of the tests.

A MODERN automotive research laboratory, designed to help develop the fuel for automobile motors of the future as well as more economical and powerful gasolines for present day cars, was dedicated recently by American Oil Company and its associate, Pan American Refining Corporation in the Curtis Bay section of Baltimore.

An outstanding feature is a "mechanical road," a chassis dynamometer which can duplicate in the laboratory every condition encountered on the road. This mechanical device permits laboratory examination of the automobile engine because the "road" moves while the car stands still.

The chassis dynamometer duplicates the conditions an engine encounters when pulling a load of any weight, climbing or descending a grade of any degree, fighting headwinds or riding with tailwinds of differing velocities, rounding curves or riding straightaways, delivering power from standing starts or under varying momentums, and traveling at any speed.

An adjustment of the controls figuratively causes roads to "slant uphill" or downhill, and twist around curves, and winds to rise, fall and shift directions. This giant machine delicately measures such factors as inertia, centrifugal force, momentum, friction of tires on highways, and is capable of testing the effect on motors of temperature, humidity and barometric pressure.

Three years in the planning stage before construction was begun, officials said this chassis dynamometer is, according to the latest available data, the largest in the world.

Photo below shows an engine dynamometer used to study performance characteristics. Horsepower per pound of fuel, economy in pounds of fuel per brake horsepower hour, as well as combustion chamber and valve deposits are only a few of the combustion research test problems.

Above — Automotive Research Laboratory Building recently dedicated by American Oil Company and Pan American Refining Corporation. It is located near Baltimore.

Center, right—The main control panel for the chassis dynamometer, which is the principal feature of the new laboratory. This mechanical "road" permits laboratory examination of an engine in action because the car stands still while the "road" moves. An adjustment of the controls in this control room figuratively causes roads to slant uphill or downhill, and twist around curves, and winds to rise, fall and shift directions. This giant machine delicately measures such factors as inertia, centrifugal force, momentum, friction of tires on highways, and is capable of testing the effect on motors of temperature, humidity and barometric pressure.

Bottom, right—A mechanical "road" technically known as a chassis dynamometer. Note the hold-down cables which restrain the car from moving off the power absorption rolls upon which the rear wheels ride. This chassis dynamometer can test two-wheel drive automobiles from small cars to trucks and busses larger than any on the highways today.

Other features of the laboratory include the single-cylinder test room for standard antiknock determination and basic motor fuel research; the multi-cylinder test room for motor fuel research which does not require a fully-equipped vehicle and, finally, a fleet of fully instrumented test automobiles with overhead valve and L-head engines, manual and automatic transmissions, and high and medium compression engines.

These four major divisions can test motor fuel under every condition of use. Antiknock quality determinations and performance tests under controlled laboratory conditions are made in the single-cylinder test room. In the multi-cylinder test room, standard automobile engines, as well as engines designed by car manufacturers for use some years hence, undergo fuel tests. Here factors such as antiknock tendencies and deposit characteristics, as well as horse power and economy are examined.

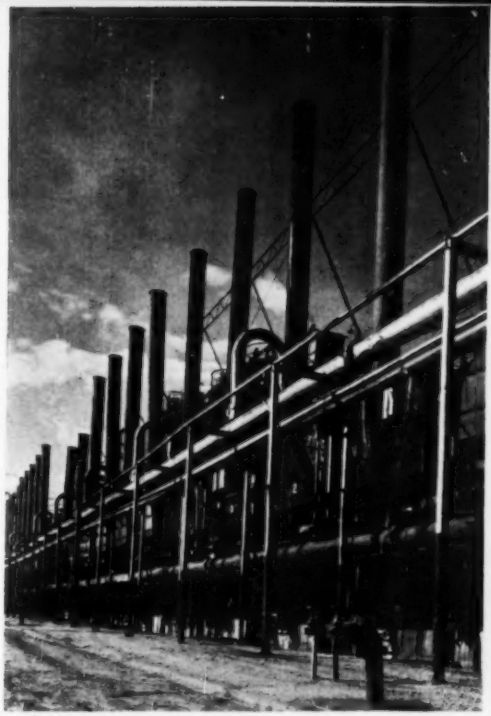
The chassis dynamometer and the fleet of test cars are the final stations. There motor fuel is tested under actual driving conditions for anti-detonation performance, vapor lock characteristics and deposit build-up tendencies.

The plant working area covers 4000 feet and can be expanded to twice its present capacity. The layout permits unit or combined operations, officials pointed out..

A Literature Review of Heaters Used by Process Plants and a Discussion of Factors Governing Selection and Operation

Fired Heaters for Petroleum Refining

MARSHALL SITTIG
Chemical Engineer
Bangor, Maine



Typical shell still battery.

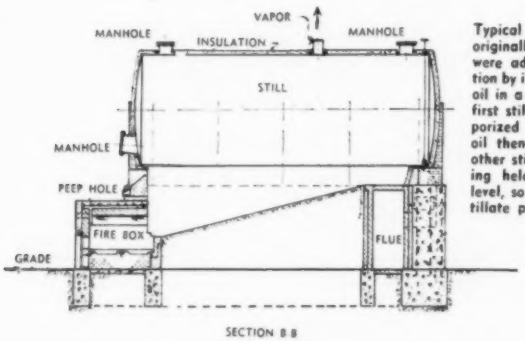
PETROLEUM distillation was first carried out in shell stills which were little more than kettles over open fires. Because of the large volume of oil per unit of heat-absorbing surface and the low velocity of movement, shell stills were limited to low input rates. Free convection, often aided by steam jets in the body of the oil,[1] gas injection,[2] or mechanical circulation means, [3,4,5] even with boiling liquids did not permit rates in excess of 3000 BTU per square foot per hour without overheating.[6, 7, 8] In an attempt to improve this, internal flues were incorporated, simulating fire-tube boilers[9], one patent on this type of apparatus issuing as late as 1932.[10] Coke deposition and burned-out bottoms have resulted from attempts to fire shell stills at rates exceeding those mentioned above.

Akin to evolution in steam generating units, the water-tube type boiler employing large header drums next appeared in the scene. The Jenkins still,[11] which also employed propellor circulation was one of the most famous of these, although the general form was widely used.[12, 13]

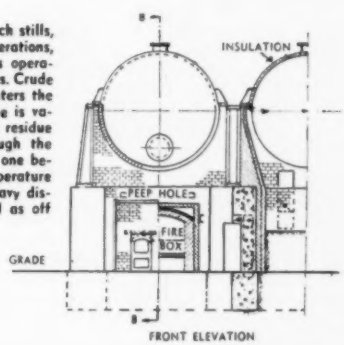
Evolution of the shell still resulted in a proposal for combined use of shell and tube stills and circulation between them,[14] as well as a shell still fired by a rotating flame to equalize the heat distribution.[15]

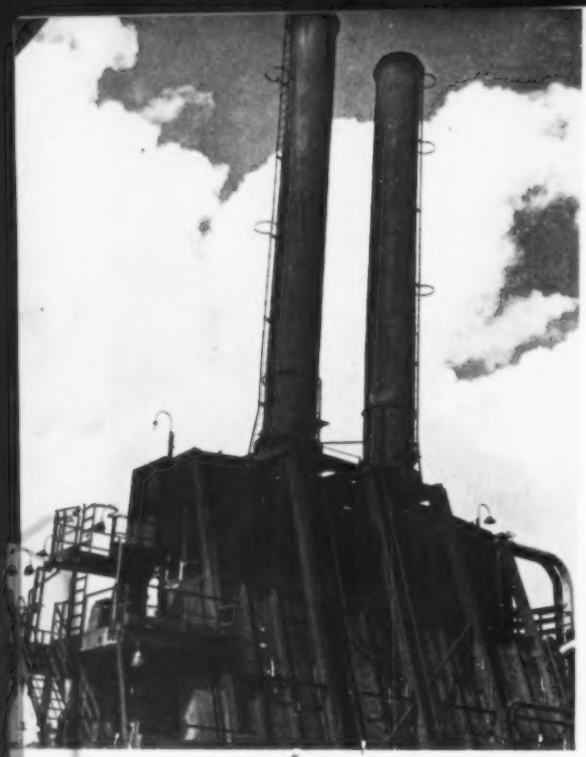
One type of petroleum apparatus, famous in the early days of cracking, which rightly falls into the classification of fired heaters and of shell stills, was the Holmes-Manley pressure still,[16, 17] mounted as a series of interconnected vertical columns heated on the sides below the liquid levels.

The main disadvantage of shell stills was their lack of adaptability to continuous operation—one



Typical shell still details. Such stills, originally used in batch operations, were adapted for continuous operation by installation in batteries. Crude oil in a shell still battery enters the first still where light gasoline is vaporized and driven off. The residue oil then flows in turn through the other stills, each succeeding one being held at a higher temperature level, so that increasingly heavy distillate products are obtained as off vapors.





An overhead convection bank type heater in which the side walls have been inclined. This design combines certain economies in structure with relatively large capacities.

of the outstanding characteristics of modern oil processing.

The advantages of the pipe still over the shell still may be listed as follows:[18]

1) Adaptability to continuous operation
2) Ease control of heating rate in pipe stills by:
   a) Adjustment of proportions of radiant and convection surfaces
   b) Use of recirculated flue gas
   c) Air preheating
   d) Changing fuel or the character of the flame
   e) Varying velocity in the tubes
3) Average transfer rate may be increased without overheating the stock thereby giving high efficiencies.
4) Pipestill operation is flexible. Capacity may range from 50 to 200 percent without harm.
5) Danger of fire is greatly reduced, due to much smaller quantity of oil in process.
6) Pipe still installations are compact. A 10,000 barrel per day pipe still (replacing 12 shell stills) occupies a square 50 yards on a side.

Varying Rates in Early Heaters

Early tubular heaters[19, 20, 21] gave average rates of 5000 to 6000 Btu per square foot per hour with hot spots in those tubes adjacent to the fires with actual rates of 15,000 to 20,000. This was remedied by shielding the tubes from radiant heat by walls. Even so, rates varied from over 20,000 in the first row to a few hundred in the last row.[22]

Reduction in temperature of gases entering the tube bank was the next problem. This was done in two ways:[6]

1) Excess air and flue gas recirculation were used in purely convection heaters.
2) Radiant tubes were installed in the combustion chamber to cool the gases prior to their entrance to the convection section.[23] Due to the small number of tubes used, they were often refractory-enclosed for protection.

High maintenance and operating costs of the first type and failures of enclosures in the second type led to the advent of the open-flame heater.

The first tube still embodying a radiant section was developed for deodorization of vegetable oils by driving off the free fatty acids and other objectionable ingredients.[22, 24] It was followed a few months later by a furnace for heating petroleum to 750° F. This represented a notable advance from the Pielsticker tube and retort combination of 1892, mentioned in the prior art in cracking.[25]

Improvement in heat generation and distribution and better understanding of the basic concepts of heat transfer have resulted in the universal adoption of open-flame heaters. The percent of radiant heat input has increased from 25 percent in early designs to 80 percent in late designs. Long runs with absorption rates in the radiant bank of 20,000 Btu per square foot per hour are used even in processing of residual oils at elevated temperatures.

In distinct contrast to this general trend toward radiant heat, however, is a specially designed furnace built by Foster-Wheeler in 1942.[26] This furnace, in a synthetic toluene plant on the West Coast, is so designed as to impart heat to the charge by convection gases only. Precise temperature control is attained through the use of this special heater.

A cost comparison between pipe and shell stills, indicative of the economic significance of this advance in the art, is presented by Nelson.[27] (Costs shown are in dollars per barrel of crude).

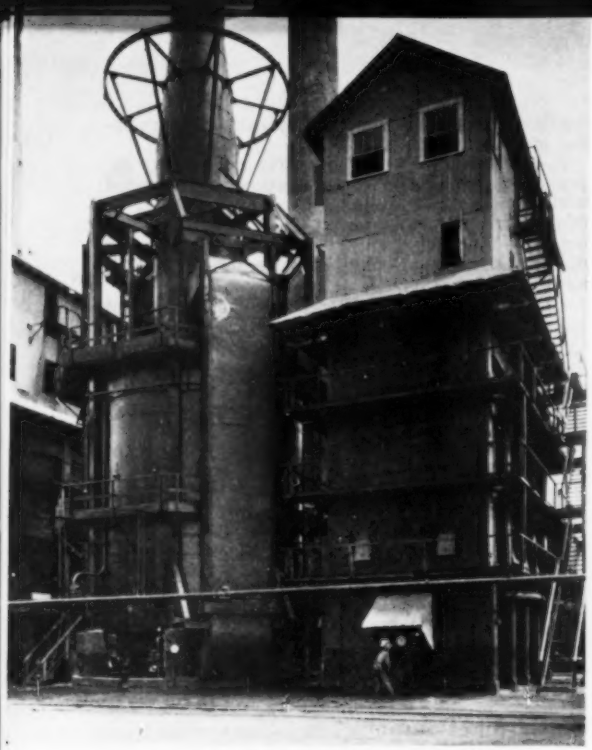
	Pipe	Shell
Distillation	$0.10	$0.30
Cracking	0.27	0.35
Coking	...	0.50

A variety of methods may be resorted to for heating petroleum stocks to distillation and to cracking temperatures. They are as follows:

1) Direct-fired heaters;
2) Heaters in which the tubes themselves are electrical resistors and are heated by the passage of electric current;[28]
3) Heaters in which tubes are supported in baths of molten metals or inorganic salts;[29, 30]
4) Steam-jacketed cracking tubes;[31]
5) Heaters utilizing heat of controlled combustion of a portion of the stock within the tubes to heat the remainder to the desired temperature;[32]
6) Dowtherm heating systems;[33] and
7) Use of molten baths through which the hydrocarbon material is bubbled.[30] This method has the advantage of intimate heat transfer and ease of coke removal.

This paper will be limited to direct fired heaters.

The heater is the heart of the thermal cracking process. The performance of this single unit may well constitute the difference between a superior and a mediocre cracking plant. Increased knowledge of the basic principles of cracking such as soaking



Typical De Florez furnace, in preheater service on a modified Holmes-Manley unit. The trolley rail serves as a hoist support for tube replacements.

time, vaporization, rate of cracking, heat of reaction, and conversion per pass has made accurate heater design possible.

Experimental solution of refinery problems involving fired heaters may be evolved by use of pilot plant installations.[34] Pilot plant heating coils are made of ¼ to ½-inch tubing which with throughputs of the order of 10 gallons per hour and slight vaporization may result in viscous flow. These tubes are inserted in molten lead baths to lessen film cracking.

According to Sachanen,[30] the following factors have contributed to the latest developments in the design of tubular heaters:

1) Use of higher temperatures in cracking;
2) Combination of cracking with straight-run distillation;
3) Selective cracking in different heaters or in different sections of the same heater;
4) Very large capacities of many modern combination units, up to 30,000 barrels per day or more;
5) Better utilization of radiant heat;
6) Higher average heat transfer rates—particularly for radiant heat; and
7) Extensive use of tube soaking sections instead of reaction chambers, with controlled heat transfer rates in these sections.

There is only one combination of temperature, pressure, and soaking time which gives maximum crack-per-pass for a given charging stock.[35] Thus the heater must be designed to permit altering these conditions within desired ranges for various feed stocks or various product specifications encountered in refining operations.

Long uninterrupted periods on steam are of prime importance from an operating standpoint. Thus, whatever may be done to increase crack-per-pass for given cracking duty must not be done at a sacrifice of length of run. This requires an accurate knowledge of the nature of the feed stock with regard to original source, boiling point, refractivity, and the optimum conditions of temperature, pressure, and soaking time.

Summaries of the application of tube stills to petroleum refining which serve as introductions to the subject have been presented.[36, 37, 38, 39, 40, 41, 42, 43]

Furnace Design Factors

Desired factors in furnace design follow:

1) Adaptability to multiple passes (for large quantities) with uniform heat distribution;
2) Tubes of uniform length;
3) Tubes as long as possible to give the minimum number of headers;
4) Tubes of one diameter;
5) Convection bank arrangement permitting adequate and economical flue gas velocities;
6) Minimum total cost of heater;
7) Not too high velocities of flue gas on account of difficulty of keeping furnace sealed;
8) Burners not too close to tubes;
9) Uniform heat distribution and control thereof; and
10) Convenient arrangement of burners and platforms for maintenance.

These factors should be borne in mind when considering the various types of furnaces.

Furnaces might be classified into three types as follows: De Florez type, Equiflux type and box type.

These furnaces vary mainly in the arrangement of tubes and walls. Most of them burn either oil or gas. Although they are rare, coke-fired furnaces may also be employed in petroleum refining.[22] Refinery coke is a good fuel and may be fed in powdered form or burned on a chain-grate stoker. The chain-grate stoker adapts itself well to temperature control.[44] Decided economic advantages result from the firing of furnaces with pulverized petroleum coke.[45, 46]

Consideration of operating data characteristic of fired heaters will serve as a preface to the discussion of furnace types.

Inlet temperatures of the stock to the cracking coil average about 600° F. Outlet temperatures from the coil vary from 900° F. to 1000° F. in the liquid-phase process or from 1000° F. to 1100° F. in the vapor-phase process. At the outlet from the coil proper, either an external reaction chamber or a soaking section integral with the furnace may be employed. The use of a soaking section, as pioneered by Winkler-Koch Engineering Company in this country, is supplanting the reaction chamber.

The temperature of the combustion chamber is usually from 1200 to 1600° F. about 10 inches from the radiant tubes.[29] Gases out from the convection section are at 800 to 1000° F. as a rule. This latter temperature may seem high but is due to the high temperature of the charge stock entering the furnace.

The capacity of the furnace coil depends on the tube diameter and the velocity of the charge. A 3000 barrel per day (fresh and recycle) unit has

tubes 2½ to 3 inches inside diameter. A 6000 barrel per day unit has tubes 3 to 3½ inches inside diameter while units of 10,000 to 12,000 barrels per day capacity have two parallel coils of 3 to 3½ inches inside diameter or one of 4 to 4½ inches inside diameter. Small tubes in parallel are preferable, due to the large heating surface offered.

The use of high pressures in cracking is beneficial from the standpoint of heat transfer and compactness of cracking equipment.

The velocity of the charge stock in the tubes is important. Velocities are usually expressed as "cold velocities," which are equivalent velocities at 60° F. A cold velocity of 5 feet per second will assure turbulent flow.[30] Velocities of 6 to 8 feet per second are used for heavy residual stocks but velocities above 10 feet per second cannot be used commercially due to the high pressure drop caused by the high velocities. It must be remembered that the pressure drop increases as the square of the velocity. Actual hot velocities are of course much higher, due to expansion and, even more, to the vaporization of the charge in the coil. High velocities are valuable both from the standpoint of increased heat transfer and because of increased allowable crack-per-pass.

The usual pressure drop in a furnace coil ranges from 200 to 600 pounds per square inch. Methods for pressure drop calculation involving graphical integration may be applied to fired heaters where vaporization occurs in the tubes.

Individual furnace types include:

De Florez Furnaces

This type of furnace has been developed by Luis de Florez and The Texas Company.[47, 48, 49] Its installation has found favor mainly with The Texas Company and Sinclair Refining Company. It is the ideal heater from the theoretical standpoint but is expensive mainly due to the tall superstructure necessary for tube removal.[18] The heater itself acts as a stack to some extent, hence only a short stack is necessary in an up-fired design. This furnace is especially suited for a vapor-phase cracking where, according to Nelson,[18] the cost is justified due to the handling of the delicate heating problem involved.

This type of heater was first built with down-draft firing and a secondary horizontal, cylindrical convection section.[6] Later down-draft heaters consist only of a vertical cylindrical section and an air preheater. Good draft is necessary in any down-draft heater such as this one to prevent mushrooming of the flame.

A vertical de Florez type with an Ascoloy air preheater but no convection section and operated with 25-50 percent excess air has an efficiency of 60-65 percent. Air preheat to 800° F., flue gas entering the preheater at 1400-1500° F. and flue gas to the stack at 800° F. are common figures for such an installation.[50]

One of the latest de Florez installations is that in the Watson, California, refinery of Richfield Oil Company. These furnaces[50, 51] are down-fired and have a design innovation of a refractory cone in the bottom to improve heat distribution.

While the circular type has the advantages of fairly simple structure and uniform heat distribution, it is expensive, difficult to add convection area to, and not susceptible to diversion of the incoming stream into increasing numbers of tubes as the heating progresses.

Various circular and near-circular furnaces have been described by others than de Florez.[52] One of these is a circular furnace comprising short vertical sections of tubing all connected in series. The burners are separated in their influence by a refractory star, and firing rates to different parts of the coil may be varied by changing the firing to one or more of the burners individually.[53]

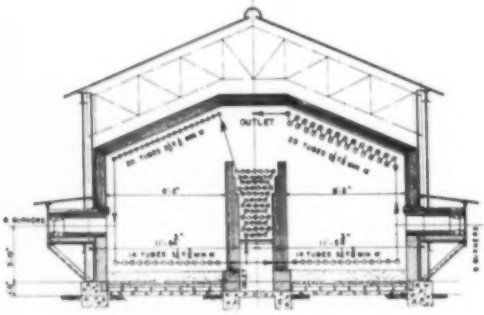
One of the latest developments in the furnace field is a prefabricated heater known as the "Iso-Flow radiant furnace." In general cylindrical shape and in the use of a cone occupying a portion of the furnace volume, these furnaces resemble the Richfield de Florez installation. An integral annular air heater may be incorporated into the Iso-Flow design. According to the manufacturer, furnaces up to 15 million Btu per hour may be shipped to the refiner as a single prefabricated structure. Larger furnaces are shipped in segmental sections for field assembly. Non-oxidizing alloys replace practically all of the conventional brick setting in this type of furnace.

A novel heater embodying some of the general characteristics of the de Florez type has been developed by Alther.[54] Tubes are provided with fins and are spaced in a circle. These fins substantially provide an enclosure by overlapping. Radiant heat is thus given out to the portions of the periphery of the tubes within this enclosure. The fire gases leave the radiant compartment and travel along the opposite sides of these same tubes, which act as a convection section.

Equiflux Heaters

Equiflux heaters have the following advantages:[6]

1) Irradiation of tubes from both sides;
2) Small cold fraction permitting high input rates;
3) Cellular structure permitting the use of any number of streams with each stream subjected to optimum thermal treatment;
4) Optimum dimensional relationship of the heater may be maintained regardless of total heat requirements;
5) Series flow through each pass assures positive flow throughout the coil—coke formation can be more readily detected by increased pressure drop, or decreased flow of oil through the coil—in most multi-flow arrangements, coking of one or more tubes



Descriptive drawing of Alcorn furnace.

does not necessarily affect the pressure drop or reduce the flow considerably;

6) Use of a number of parallel passes (with series flow through each pass) reduces pressure drop and pumping costs;
7) The use of a larger number of smaller tubes reduces the time during which the oil is at maximum temperature—important in many heating cycles where the oil is sensitive to high temperatures; and
8) The cell construction is combined with updraft firing of the heater, giving simple gas flow without baffles or turns.[55]

Alcorn Furnaces

Alcorn heaters have been characterized by combustion chambers or muffles[30, 56, 57, 58] in which fuel oil or gas is burned under accelerated combustion conditions of intimate mixing at high temperature. From the combustion chambers, the flame and products of combustion are directed outward and above floor tubes and between the floor and roof bank of tubes. The gases then pass over a bridge wall and downward through a convection section. In two-compartment heaters an updraft convection section may also be utilized. A multiplicity of burners results in uniform heating throughout the tube length. The roof is sloped to further the uniformity of heat input.

The two-compartment heater was developed for the purpose of controlling the application of radiant heat. This heater is identified as a double-end fired heater which offers great flexibility in operation, since there may be a high-heat input in both of the chambers, or a low-heat input in one with a high-heat input in the other, making it possible to vary the heating curve in the coil.

A modification of the double-end fired heater, or two-compartment heater, is a three-compartment heater, which utilizes an updraft convection section with separate streams in the outside compartments and a third stream in the middle compartment. This type heater has wide usage on processing operations where positive temperature control of three streams is required. Another recent development, principally for low temperature operations, is a rectangular heater consisting of wall tubes with end firing parallel to the tubes, and in the rear, in the path of the exit gases, is arranged a finned tube convection section.

Two-Compartment Heaters

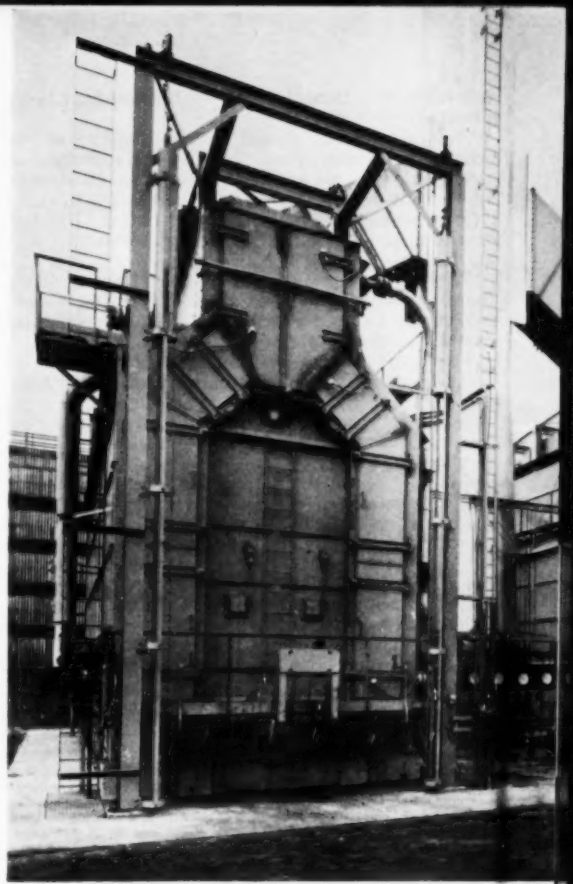
This type of heater is also known as the center-convection type and as the double-end fired heater.[59, 60]

Separate combustion chambers operating independently give more definite control of the heating rate than the up-draft rectangular heater, which in turn is superior to most box type furnaces.[6] It may be used for parallel flow of two oil streams, each utilizing one end of the heater.[61]

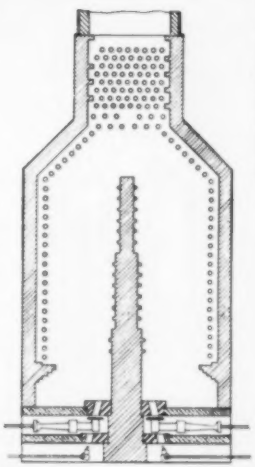
Up-Draft Rectangular Heaters

This type of heater has been developed and advanced primarily by The Lummus Company.

Special tiles (Lummus patented diffusion baffle tile) placed above the top row of roof tubes act as distributing baffles and give a high gas velocity over the shielded section of these tubes to partially equalize the heat pickup of these tubes. Such a velocity effect may also be produced by using fins or tubes in place of the tiles or by the use of bifurcated tubes spaced on very close centers.



Above—Universal Oil Products updraft heater.



Right—Descriptive cross-section drawing of center wall updraft heater.

Down-Convection Furnaces

These are used in general service. This type of heater averages 40 percent of the heat input in the fuel to the radiant section, and 30 percent of the heat input to the convection section.[18]

A great variety of minor variations from the

general down-convection type of furnace have been patented.[62, 63, 64, 65, 66, 67, 68,]

The principle of steam injection to the oil in process is widely used.[69, 70, 71] The superheated steam aids in fluid and heat flow in the oil stream and may be essential to further processing in catalytic processes such as dehydrogenation, Houdry cracking, and Universal Oil Products catalytic polymerization.

Various patents on multi-chamber types provide for diversion of the flue gas from the first chamber, partly to the stack, and partly to a second or convection chamber.[72, 73, 74]

This type of construction may be utilized for steam generation.[75] If the quantity of steam generated from this set-up is insufficient for refinery requirements, additional steam may be obtained by installing radiant boiler tubes in the furnace of an existing oil still.

Among the sensitive oils processed in Dowtherm heating systems are lube oils which are subject to discoloration and deterioration if the critical temperature at which they are to be processed is exceeded. Until recently the only available method of doing the job where oil temperatures approach-700° F. were required was to pass the oil through tubes exposed to the direct heat of a fuel fired furnace. To attain this with an average oil outlet temperature of about 650° F., the oil film temperature on the tube walls heated by hot furnace gases might well exceed the desired limit of 700° F. maximum and result in injury or breakdown to

The simple pipe heater on the left was built about 1923 for use with a bubble tower (not visible) for the atmospheric distillation of heavy Mexican crude oils. The unit on the right was added about 1925 when the production of "black oil" was desired. It consists of a return-tube shell still with an integral rectangular bubble tower and reflux condenser. It is operated under "dry" vacuum. The vacuum jets can be seen in the overhead structure. The assemblage operates as a two stage distillation unit. It is now used to distill refinery slop. This and photo on page 149 courtesy Humble Oil & Refining Company.

that portion of the oil exposed to film temperature.

A heater which, although it is not employed in heating petroleum products, finds important application in modern refinery processing is the direct-fired air heater.

These heaters are designed especially for the purpose of delivering air at high temperature (1000-1500° F.) and high pressure (3-50 pounds per square inch) required in numerous processes for making high-octane gasoline and butadiene. The fuel-gas or oil burns directly in a portion of the air stream to be heated. The final temperature is controlled by tempering the combustion air with the balance of the air stream before reaching the heater outlet.

Radiant Heat Transfer

Rickerman, Lobo, and Baker[76] give safe radiant transfer rates up to 13,000 Btu per hour per square foot of exterior surface for gas oils and up to 10,000 for black oils. Mekler states, however,[6] that much higher rates (15,000 to 20,000) are used in some heaters. In soaking tubes, Sachanen[28] states that moderate rates (less than 10,000) must be used to prevent coke formation in the more advanced stages of cracking.

Empirical formulas for radiant heat transfer in steam-boiler furnaces followed by a description of performance tests on various types of tube still refinery furnaces have been published. Equations for the fraction of available heat absorbed in the radiant section have been presented.[77, 78, 79, 80, 81, 82, 83]

Residual heat in the gases leaving the radiant chamber is recovered in various ways:[6]

1) Supplementary tube banks or convection sections and
2) Air preheaters

High inlet oil temperatures often give rise to the use of both, especially where high fuel costs justify the use of air preheaters.

The mechanism of heat transfer in convection sections is complex, in that, due to gas temperatures (1300-1800° F. inlet and 800-1100° F. outlet), part of the heat is supplied by radiation, depending on:

1) gas temperature;
2) carbon dioxide and water content of the gases; and
3) clearance between tubes, which determines the shape factor of the radiant layer.

Pure convection transfer may be expressed by the use of Monrad's well known equation.[84] This coefficient in such sections varies from 2-4 Btu per hour per square foot (° F.) in practice and represents 30 to 60 percent of the overall coefficient in the average convection section.

Recirculation and Air Preheat

In flue gas re-circulation the flue gas is reheated by the flame, causing a lower flame temperature and milder radiation rate along with high gas velocity in the convection section.[16, 85, 86, 87, 88, 89] The greater the ratio of weight re-circulated to weight passing up the stack, the more duty is transferred from the radiant to the convection section.

Air preheat has the opposite effect in that it increases the flame temperature. It increases still

efficiency by cooling the stack gases.[16]

Much of the fundamental work on application of air preheat and flue gas re-circulation may be attributed to the late J. E. Bell of Sinclair Refining Company. His patents, many of which are for coal-fired heaters, are numerous.[90, 91, 92, 93] Sinclair interests have been foremost in furthering industrial development of Bell's fundamental work in a series of patents,[94, 95, 96, 97] although many others have issued to other companies in the fields.[98, 99, 100, 101, 102, 103, 104]

Concrete figures on savings introduced by the use of air preheaters in conjunction with oil stills have been presented by Creutz of Air Preheater Corporation.[105] In another publication Air Preheater Corporation presents data showing from 11 to 15 percent increased still efficiency and from 18 to 22 percent fuel savings resulting from the use of various air preheat combinations.[106]

As mentioned in the section on convection theory, the design of a fired heater involves first determining whether a convection bank or an air preheater will be more economical and whether a combination of the two will give maximum economy. Optimum economy is not necessarily maximum efficiency because values set on fuel saving will determine how far it is economical to go in saving heat.

Choice of Still Tubes, Metallurgical Considerations

Alloy steel tubes have largely replaced carbon steel, primarily for the reduction of corrosion. The question of the choice of alloy is largely one of economics. This involves balancing the initial cost of the alloy tubes vs. the replacement of the steel tubes, the down-time of the unit in making the replacements, and the hazard due to failure of the steel tubes.[107] An evaluation of alloy cracking still tubes has been presented by Nelson.[108]

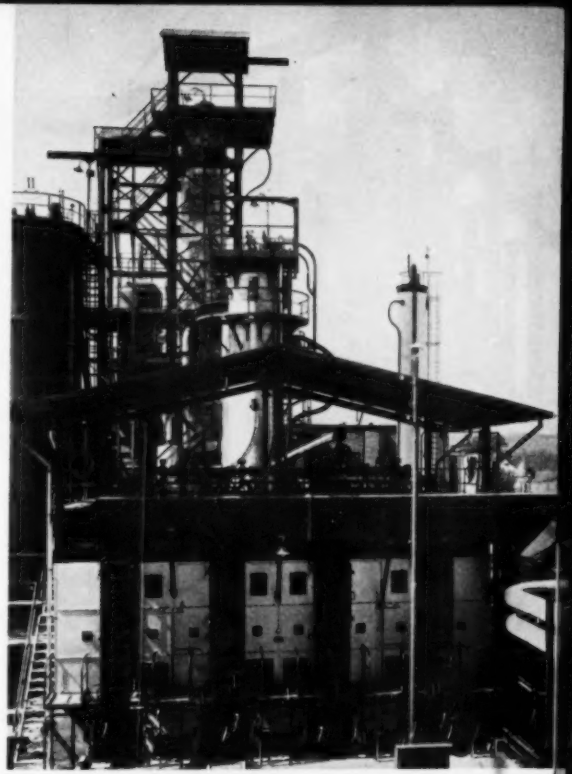
In addition to the use of alloying elements to prevent corrosion as well as oxidation due to furnace combustion, tubes may be aluminum-coated inside and out. These are known as calorized tubes.

Alloys used in tubes have a lower heat conductivity in general than plain steel. The question of thermal conductivity at elevated temperatures has been the subject of much recent research.[109, 110, 111] It has been found that although plain carbon steel tubes are superior in conductivity at low temperatures, as temperatures are increased points are reached for certain grades where superiority is reversed, i. e. the plain carbon steels are inferior.[109]

New refinery processes, such as thermal polymerization with its attendant severe conditions, require new tube materials.[112] Closely allied to the problem of tube materials is the choice of tube support materials.[113] Hightower[114] discusses the metallurgical requirements in butadiene manufacture.

A great variety of mechanical shapes for cracking tubes have evolved in the development of the art. Among these are spirally corrugated cracking tubes,[115] tubes containing helical cores,[116] tubes containing solid rod cores,[117, 118], double-walled tubes with oil in the annular space and flue gas passing through the inner tube as well as outside the outer tube,[119] and double-walled tubes wherein the oil is so charged as to revolve at high velocity and produce a film on the heating surface.[120]

Higher gasoline yields as well as higher allowable space velocities due to better heat transfer are benefits attributed to the use of baffled tubes in fired heaters for vapor-phase cracking operation by Canadian investigators.[121, 122]



DOWNDRAFT EQUIFLUX HEATER

Top—Photo shows UOP four-cell downdraft Equiflux heater.
Below—Descriptive drawing is of UOP five-cell downdraft Equiflux heater.

Fuels and Burners

In the final analysis, coal firing is rarely employed in fired heaters for petroleum refining. Oil, gas, or combined firing are the common choices.[123]

Various types of waste by-product fuels produced in an oil refinery may be burned in refinery furnaces.[124, 125, 126] Wilson of Standard Oil Company of New Jersey classifies these fuels as follows:[124]

Heater designed with overhead convection bank. The burners are located low on the side wall to the right, below the radiant wall tubes. They fire against the bare refractory wall on the left. Future tubes can be added on this bare wall, with the burners to then be relocated in the end walls of the furnace.

1) Sludges—
   a) From treating gasoline and kerosine
   b) From treating heating oils and other products
2) Tars
3) Tank cleanings or bottoms
4) Non-merchantable coke.

Recent trends in burner design point to the "short-flame" type. This type with its greater speed of combustion results in higher heat release and lowers secondary combustion which results in hot spots and tube failures.

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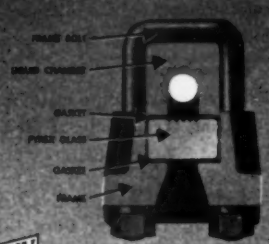
only PENBERTHY *Reflex* LIQUID LEVEL GAGES *Have All These Features*

Drop Forged Steel

1. **PROTECTED GLASS.** Frame completely contains glass—no part exposed. Glass supports none of frame weight.
2. **UNIFORM GASKET PRESSURE** assured by precision finishing of retaining surfaces.
3. **EQUAL RESILIENCE ON BOTH SIDES OF GLASS** due to interchangeable gaskets which also prevent improper reassembly in the field.
4. **PERFECT GASKET JOINTS WITH MINIMUM BOLT TENSION** because misalignment of parts is impossible. This also eliminates frequent cause of glass breakage.
5. **DISTORTION PREVENTED** by reinforcing beam and scientific distribution of metal in frame. (Distortion is a serious cause of glass breakage.)
6. **GASKET BLOW-OUTS PREVENTED** by full metal backing of surface and periphery of both gaskets.
7. **RIGIDITY AND PERFECT ALIGNMENT** assured because liquid chamber is machined from solid block of temperature resistant steel heat treated to prevent warping.
8. **PYREX GLASS** is used exclusively because it has proved far superior in resistance to thermal shock and erosion.



Penberthy Reflex Gages make reading of liquid level easy and unmistakable; empty space always shows white—liquid always shows black. They are made in any length desired and from various materials to successfully withstand corrosion, contamination and high temperature conditions. Conform with API—ASME standards.

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EMPTY SPACE SHOWS **WHITE**

LIQUID SHOWS **BLACK**

Inside stuff *on a good blower*

The blower casing, backplate, inlet connection, and guide vanes, all stationary parts in contact with the medium being handled, are normally made of cast Meehanite. When operating conditions, such as temperature or corrosion, demand, any or all of these parts can be made of steel or nonferrous alloys. With the backplate separate from the base and bearing housing, the use of special alloy material is kept to a minimum.

The open type, one-piece impeller may be made of any material required by the service. Since the impeller is essentially free from end thrust, a relatively simple thrust bearing may be used. Another factor of prime importance is that, with the open type impeller, the packing box seals against blower inlet pressure only, minimizing the possibility of gas leakage to atmosphere.

Elliott centrifugal blowers, single and multi-stage, have a long record of exceptionally satisfactory service in industries requiring the moving of air or gas. Full details in Blower Bulletin P-7, at request.

P-1085

Impellers are balanced statically and dynamically, and are overspeeded well beyond maximum operating speed before assembly with the blower unit.

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ELLIOTT *Centrifugal* BLOWERS

REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

J. E. FENEX | A. W. HOGE | LEE FRIEDMAN | K. KEITH OKAMOTO

Trio Describes New TCC Unit Operation

TWO Houdry Process Corporation men, A. Wesley Hoge and Lee Friedman, collaborated with J. E. Fenex, regional refinery superintendent, Western division, Continental Oil Company, in writing the account of the initial operations of Conoco's catalytic cracker at Denver. (See page 103.)

Fenex, born in Wyoming, joined Continental as a stillman in January, 1922, later became shift foreman, then assistant superintendent at the Wichita Falls plant. When the Denver refinery was completed in 1931, he went there as superintendent where he served until switched to the then new Lake Charles refinery as superintendent. He has carried his division title and a Denver residence since April, 1948.

Hoge is not new to REFINER readers, he having been one of the authors of a Lion Oil Company story that appeared in December, 1948. He is a metallurgical graduate of Ohio State and prior to joining Houdry Process Corporation did pilot plant and cracking process development work six years for a Philadelphia gas company. With Houdry since 1933, his activities have been along technical service lines and at present he is manager of the technical service and plant operations department.

Friedman was born and reared in Philadelphia, took a B.S. in petroleum engineering from Penn State and then went to Texas A.&M. where he received his master's degree. As the photo shows, he did a stint in the U. S. Navy and as an engineering officer on an LST was close around during the Normandy Beach operations. He was employed by Phillips Petroleum Company in the natural gasoline department commencing in 1941 for several years before donning the uniform. Now his work is in Houdry's technical service department as a chemical engineer. Golf is one of his favorite sports and reports, which he is too modest to confirm, say he turns in pretty low scores. He is also a handball enthusiast. Music, too, has its charms.

Van Winkle Aide

K. KEITH OKAMOTO: co-author with M. Van Winkle of "Correlation of Equilibrium Flash and True Boiling Point Distillation Curves at Sub-Atmospheric Temperatures" (starts on page 113), was born September 15, 1920, in Upland, Calif., attended Chaffey Junior College, Ontario, Calif., and received an associate of arts degree. Then he was enrolled at the University of California for one year and the University of Tulsa for two years with an interval of two years spent on active duty in the Armed Services of the United States in the Pacific war theater. He received his Bachelor of Science in Petroleum Engineering in 1947, from the University of Tulsa and his Master of Science in Chemical Engineering at the University of Texas in January, 1949. At present he is working on his doctorate and is an assistant in the chemical engineering department.

Okamoto is a member of the Phi Lambda Upsilon and Omega Chi Epsilon. Outside of his main interests in chemical engineering and petroleum refining, time permitting, he is occupied with flying, photography and gymnastics.

Van Winkle has been a several-times contributor to the REFINER, his most recent article having been published in January, 1949, "Pressure - Temperature Correlations for Petroleums and Hydrocarbons."

Unusual Plant Setup Is Detailed by Pair

"FEAZEL and Kinsey Plant Employs Unusual Design" is the title of the article contributed by Roy A. Schuster and Robert M. Stewart, of The Chicago Corporation, Corpus Christi, Texas. The article describing the additions made to the plant in the Carthage field begins on page 91 of this issue.

Schuster, friendly and efficient general superintendent of plants, is a dyed-in-the-wool natural gas-gasoline engineer from long experience with the industry from research to operations. He was graduated from Case Institute of Technology in Cleveland, Ohio, in the "crash" year, 1929, which may or may not have influenced his selection of occupation. At any rate he was associated with the subsidiary companies of Columbia Gas and Electric Corporation in the natural gasoline division for something over 15 years. During this time he lived in Ohio and then in West Virginia. He joined The Chicago Corporation in 1945.

Stewart, red-headed, able assistant general superintendent, hails from East St. Louis, Ill. He attended school in Salem, Ill., and was graduated with a bachelor's degree in chemical engineer-

ing from Missouri School of Mines and Metallurgy in 1939. His first job was junior engineer and chemist for The Texas Company at Salem. Then he entered the air force as a second lieutenant in 1941. After service in the South Pacific, he was discharged in 1945 as lieutenant colonel.

Stewart joined The Chicago Corporation in January, 1946, as process engineer. In October, 1947, he became division engineer in the plant department and has been assistant to Schuster since the first of this year.

He is a member of Alpha Chi Sigma, Air Reserve Association, Reserve Officers Association, and a registered professional engineer in Texas.

New Tools for Gas Men Told by Foster

T. R. FOSTER, manager of turbo machinery sales for Clark Bros. Company, Inc., Olean, N. Y., is better known to his co-workers and friends as "Ted." His article, "Applications of Centrifugal and Axial Compressors" which contains valuable information about where this equipment fits into today's process plants, begins on page 98. Foster discussed these points before the American Gas Association meeting at French Lick several months ago.

Foster, a graduate of Georgia Institute of Technology, has been engaged in application of centrifugal type machinery for about 20 years. He has specialized in oil and gas industry applications for the past eleven years. He is a member of ASME, ASRE, API, and AGA.

Foster's chief hobbies are golfing and swimming, most of which takes place just off his front doorstep in Cuba Lake. He advises that he is convinced that hobbies such as drawing plans for his recently constructed lakeside home and personally grading the future lawn should not be encouraged. "I'll stick to golf and swimming in the future and refrain from encroaching, even momentarily, on the architect and building contractor's respective fields of activity," he promises.

MARSHALL SITTIG

Big and Commendable

MARSHALL SITTIG, author of "Fired Heaters for Petroleum Refining" (see page 143), includes among his hobbies "keeping abreast of developments in the petroleum industry," which to an editor is as commendable as it is sizeable. Because with developments coming as fast as they are, that's a stupendous task. An editor should know because trying to do that same thing is included in his own daily agenda.

Sittig was first introduced to the petroleum industry by G. F. Olsen of General Petroleum Corporation of California, who hired several Purdue University men for summer work after their sophomore year. After a brief period in the General Engineering Department of Standard Oil Company of California and a semester of graduate work, the writer joined a major chemical company where he spent five years in the manufacture of raw materials for synthetic rubber and a year in engineering research. Currently, he is engaged in chemical engineering studies for a paper manufacturer.

When he gets through with his day's work, he keeps busy with scale-model making, and trying to keep up with his two daughters, aged one month and three years.

Refining Wins Over Geophysical

J. C. HANNAH worked one summer with an electrical geophysical crew in his native state of New Mexico and then two summers as a tester at the Artesia, N. M., refinery of Continental Oil Company. As a result, the title of the article he has contributed to this issue of PR indicates the division of the industry that interested him most—"Fractionating Absorbers in the Petroleum Industry," beginning on page 135.

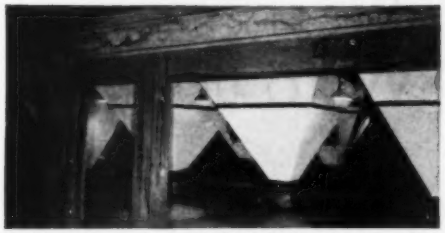
Hannah graduated from Oklahoma University in 1941 in chemical engineering. His initial training as a refinery engineer he received with Shell Oil Company, Deer Park, where he was a three-year trainee. From 1944 to 1947 he was in New York for work in research.

The wind-swept wide open spaces called but, determined to be a process engineer, he compromised between the city and the open range and joined The Fluor Corporation, Ltd., Los Angeles. He has designed several gasoline, LPG, treating, and chemical plants since joining Fluor. He reports that his most enjoyable job with Fluor was the eight months spent near Death Valley at the American Potash & Chemical Company Trona plant.

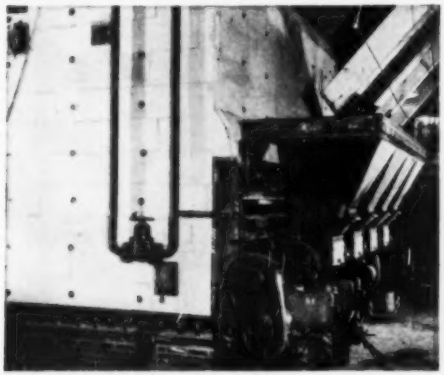
His hobbies are competitive—swimming and skiing versus his wife and eighteen-months-old son. Correction: His hobby is his family.

T. R. FOSTER ROBERT M. STEWART ROY A. SCHUSTER J. C. HANNAH

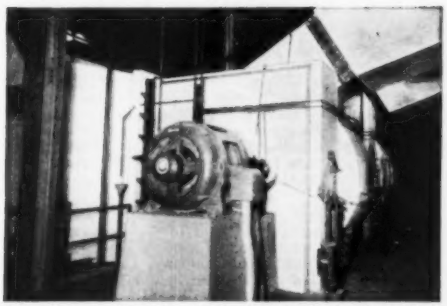
KAYLO® Heat Insulating Block



Precipitator hoppers insulated with Kaylo Heat Insulating Block



Kaylo Heat Insulating Block covers boiler



Power house equipment insulated with Kaylo Heat Insulating Block

The ONE material to combine these advantages...

Handles wide temperature range . . . has low thermal conductivity! Kaylo Heat Insulating Block is ideal for jobs involving temperatures from 200° to 1200° F. It maintains its thermal stability, isn't affected after exposure and service. Then, too, due to its very fine cellular structure, its conductivity remains low at top operating temperatures, making it one of the most efficient and economical insulating materials.

Has low density . . . high compressive strength! Kaylo Heat Insulating Block's low density simplifies handling, shipping and application. It weighs only 11 pounds per cubic foot—less than one pound to the board foot. Yet, Kaylo Heat Insulating Block has an unusually high compressive strength for a mineral product of such a light weight.

High flexural strength! Because Kaylo Heat Insulating Block has a high flexural strength, it is easy to handle and apply . . . contributes to long service, low maintenance.

Typical Applications of Kaylo Heat Insulating Block

Breechings	Lehrs
Hot Air Ducts	Autoclaves
Tanks	Ovens
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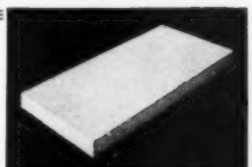
Dryers	Turbines
Evaporators	Chilling Pits
Heat Exchangers	Boilers
Condensers	Precipitators
	Locomotives



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Please send:

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- ☐ Free sample of Kaylo Heat Insulating Block.
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Maintenance and Operation—

HOW TO DO IT

HOW TO—

Recondition Small Valves Quickly

LEAKING valves in a process plant, besides being a source of annoyance to operators, foremen, and superintendents, usually are hazardous to a great extent. Small valves, especially on instrument lines are not exceptions to this rule, although these valves can be replaced, taken to the shop for repair, and then placed in stock for reuse. If the valve cannot be repaired in place, continued service until it is replaced sometime later, may result in the valve being worn beyond repair causing it to be discarded.

A tool for use in refacing the seat and needle of ¼-inch and ½-inch needle valves in place in the line has been designed and built by C. E. Murphey, gas measurement superintendent, United Gas Pipe Line Company, Carthage, Texas. The tool is illustrated in the accompanying photographs. It consists of the reamer and pilot or guide, Figure 1. The opposite end of the reamer is used for dressing the valve needle. Repairing the valve in place saves the cost of a new valve and the time required for replacement.

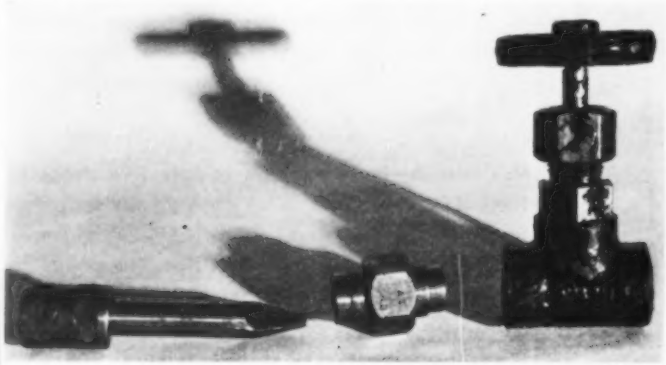
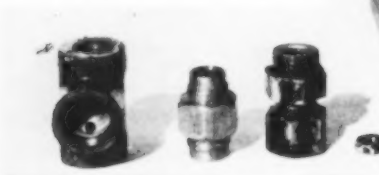


Figure 1—Repair tool for ¼-inch to ½-inch valves. The reamer for refacing the valve seat is at the left and the reamer pilot or guide is at the center of the picture. Since the bonnet and stem opening in the bodies of the valves of various manufacturers differ in size, the pilot is provided with four extensions or shoulders of different diameter. The extension fitting snugly into the bonnet opening is used to keep the reamer from wobbling on the valve seat. Size of the repair tool is indicated by comparison with the ½-inch valve at the right.

Figure 2—With the pilot or guide in position in the valve body through the bonnet opening the reamer is inserted and turned in a clockwise direction by hand until the valve seat is smooth. Note the slot in the end of the reamer, which is used in refacing the needle.

Figure 3 ⟶

When the valve seat has been refaced, a small piece of emery cloth is folded and the folded edge inserted in the slot provided in the opposite end of the tool from the reamer. The end of the needle is placed in the tapered opening provided by the emery cloth and turned by hand until it is smooth. The valve is then re-assembled.

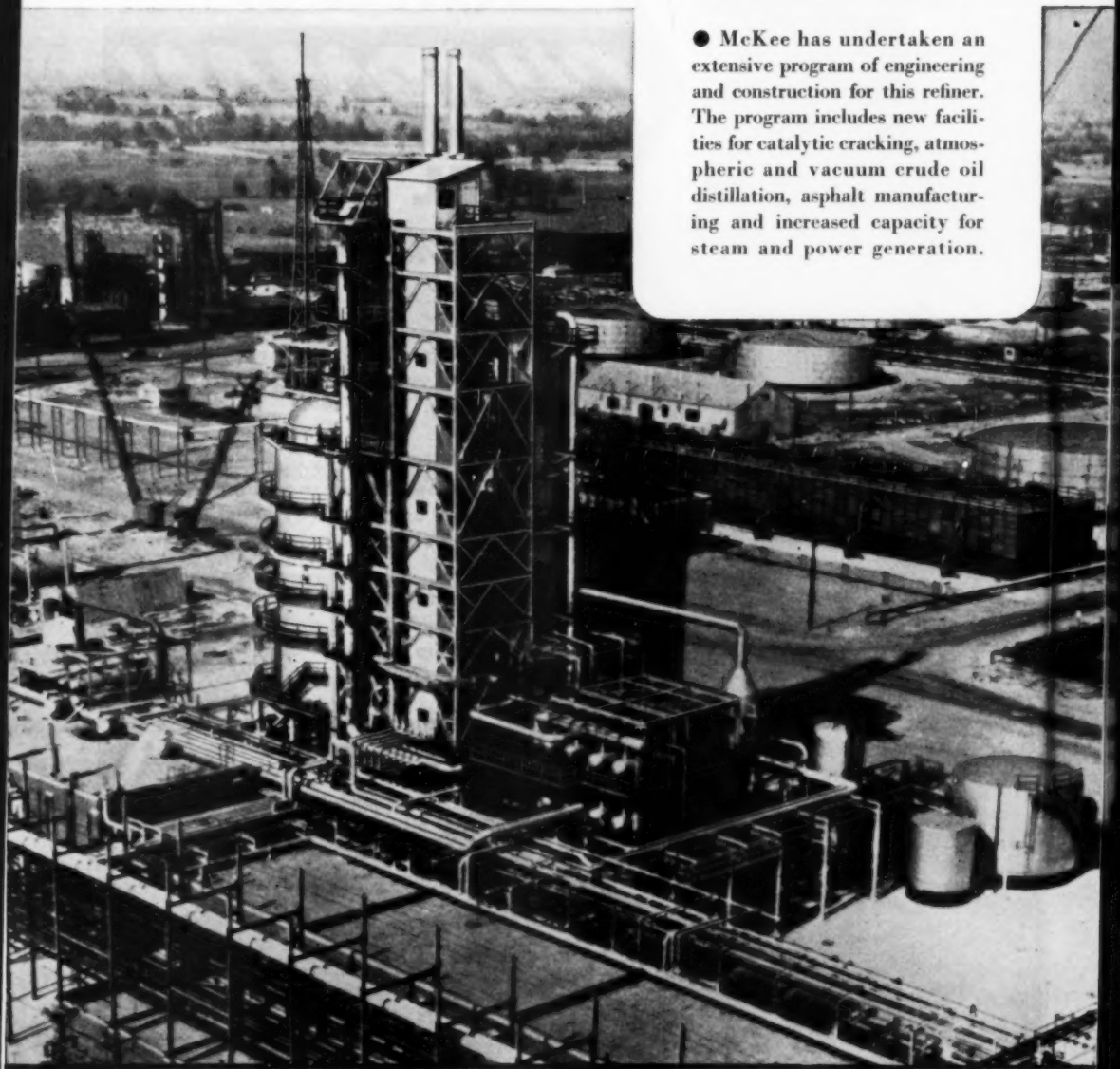


After the bonnet and needle have been removed from the body of the valve the pilot is placed in the opening over the seat. Note that the pilot has four extensions, each of different diameter. The extension that fits snugly into the particular valve body is used to seat the pilot or guide, Figure 2. Then the reamer is inserted through the guide and turned in a clockwise direction by hand until the seat of the valve is smooth.

To smooth the needle, a small piece of emery cloth is folded and placed in the slot in the opposite end of the reamer as shown in Figure 3. The needle is rotated by hand in the tapered opening until it is smooth.

NEW CATALYTIC CRACKING UNIT

Engineered and Constructed by McKEE



● McKee has undertaken an extensive program of engineering and construction for this refiner. The program includes new facilities for catalytic cracking, atmospheric and vacuum crude oil distillation, asphalt manufacturing and increased capacity for steam and power generation.

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

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3 REASONS WHY CHAPMAN STEEL VALVES *are your best buy*

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Whenever you need Steel Valves—gate, globe, angle, or check—come to Chapman first. Backed by years of research, development and performance, Chapman Steel Valves are your guarantee of better . . . longer service.

The Chapman Valve Mfg. Co., Indian Orchard, Massachusetts

HOW TO—

Pump 2500 Barrels a Day From 3-Foot Water Sand

A METHOD of obtaining a large quantity of water from seeping sand has been developed at the Waggoner Refinery, W. T. Waggoner Estate, near Electra, Texas, where a "horizontal" well has drawn 2500 barrels a day from a three-foot thick sand formation since 1944.

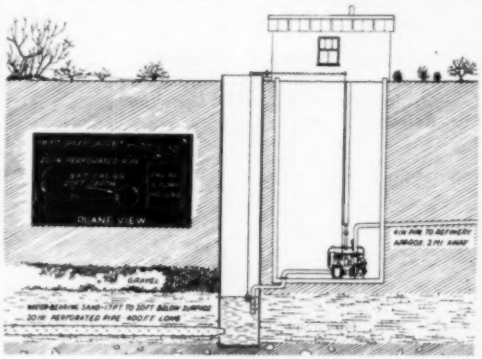
Superintendent J. O. Walkup designed the somewhat unusual well that year to meet an emergency: the plant was threatened with closing because the city was unable to supply enough water to meet its requirements. Another source had to be established quickly. The well was sunk, and water transferred from there to the refinery through two miles of four-inch pipe by the engine-driven centrifugal pump.

This 79,000-gallon-a-day supply, augmenting quantities obtained from the city and from three outdoor tanks has made it possible to continue operations.

Principal feature of Walkup's method is the use of two 400-foot lengths of 20-inch pipe, imbedded in the water sand 18 feet beneath the surface. Quarter-inch slots in each pipe, staggered around the circumference and down the length, permit water to seep in from the sand.

The Waggoner well is able to drain water quickly from the low-pressure reservoir of seeping sand due to the large amount of water-gathering surface exposed to the sand. A conventional well shaft would contact the water formation only in a three-foot vertical cross-section, extending around the circumference of the shaft.

On the other hand, the pipes, stretching along the length of the formation, contact a far greater area of water-bearing sand. Consequently, a larger quantity of water seeps into them than would into an ordinary well shaft. Fortunately, the formation at the Waggoner Refinery has the capacity to replenish its water content.



When the pipes were buried, Walkup covered them with scrap sheet metal, then a two-foot layer of gravel, to guarantee that the slots would not be clogged with dirt.

Water drains from the gathering pipes into a casing five feet in diameter and 20 feet deep. It is pumped from there to an open tank at the refinery, where it is used in boiler feed circulating pumps.

A shaft sunk beside the casing houses the engine and the pump as shown in the photograph. Operating 24 hours a day, the engine maintains a flow of 50-60 gallons per minute, under pressures ranging from 60 to 100 pounds.

Pumping rate is regulated by a float control in the casing, which automatically slows the engine when the water level is low, speeds it up when the level rises. Water is lifted vertically approximately 50 feet overall on the trip from casing to tank.

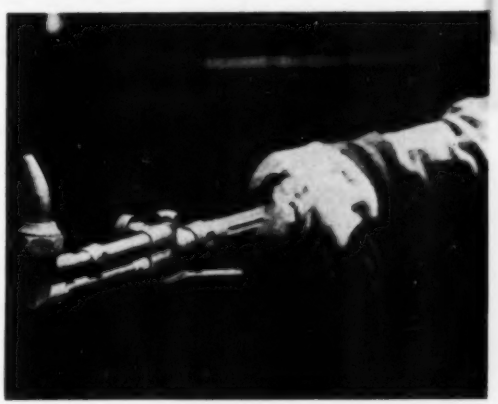
(Article and photographs by courtesy of Industrial Power Division, International Harvester Company.)

HOW TO—

Adapt a Standard Torch To Gouge Old Weld Bead

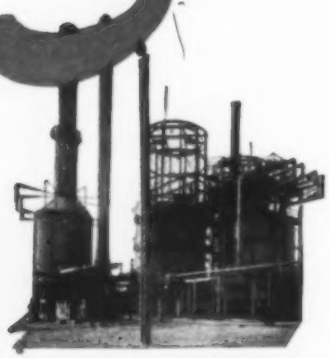
A WELDER with a store of experience gained by rebuilding refinery and gasoline plant vessels has adapted a standard acetylene cutting torch to one which expedites gouging out old weld beads.

The tip is bent to an angle of about 35 degrees, the bend being made slowly so as not to collapse or distort the ducts and passageways for oxygen and acetylene. When the tip is laid against the old bead which is to be washed out, the angle of approach is such that a shallow gouge is obtained instead of a cut. A bead can be washed down to the parent metal with greater ease and with less damage to the sheet.



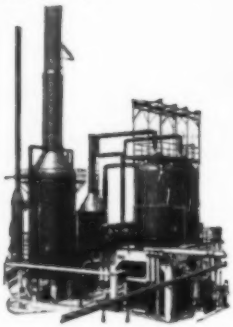
The method provides the welder with an unobstructed view of the work, which prevents damage to the parent metal.

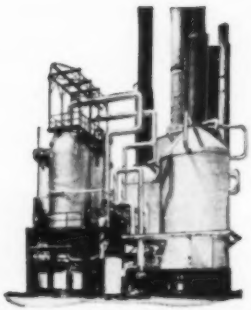
5 More PERCO* Units



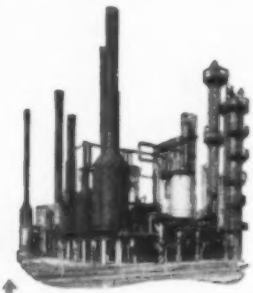
WOOD RIVER OIL & REFINING CO., INC., Hartford, Ill. — 10,000 B/D Straight Run and Cracked Gasoline Reforming and Gas Oil Cracking.

KANOTEX REFINING COMPANY, Arkansas City, Kansas — 4,200 B/D Straight Run and Cracked Gasoline Reforming.



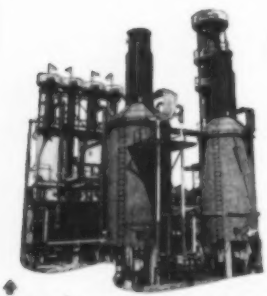


NATIONAL COOPERATIVE REFINERY ASSOCIATION, McPherson, Kansas — 5,000 B/D Straight Run and Cracked Gasoline Reforming.



BARECO OIL COMPANY, Wichita, Kansas — 4,000 B/D Straight Run and Cracked Gasoline Reforming.

engineered by KOCH



ROOSEVELT OIL & REFINING CORP., Mt. Pleasant, Michigan — 3,000 B/D Straight Run Gasoline Desulfurization Reforming.

5 more refiners are far ahead in the octane race because they chose Perco catalytic reforming units. With Perco units they can upgrade the leaded octane ratings of their gasolines by 6 to 8 numbers or more. Regardless of size, these Perco units cost less and are far more flexible than thermal reforming units. The economical design of a Perco unit requires years of "know how" — the kind of experience Koch has obtained by building many more Perco units than any other company. We will be glad to tell you how much a Perco unit will cost and what it will do for you . . . no obligation. *Write us, today.*

* Licensed by Phillips Petroleum Company

THE KOCH ENGINEERING COMPANY, INC.

DESIGNERS • MANUFACTURERS • BUILDERS

808 WEST LEWIS STREET • WICHITA 2, KANSAS

THE MONTH *in the* INDUSTRY

RECEIVES AWARD—The National Safety Council's "Distinguished Service to Safety Award" last month was presented to Standard Oil Company of California for achieving one of the nation's most outstanding safety records during 1948. Presentation of the award was made to T. S. Petersen (left in photo above), president of Standard and to R. E. Donovan (right), Standard's chief safety engineer, by Robert A. Pike (center), the Council's Western Regional Director.

Anglo-Iranian Head Sees Shorter Profits in 1949

The market recession from exceptional conditions which obtained in 1948 "is a clear warning that the over-all position in the petroleum industry is changing and that profit margins of the 1948 level should not be looked for in the current year," according to Sir William Fraser, Anglo-Iranian Oil Company's board chairman.

Sir William also noted that the rise in oil supply that began toward the end of 1948 has been reflected in substantial reductions in world prices of fuel oils and middle distillates, although world demand continues at high levels.

Additions being made to the Abadan refinery will give better flexibility of operation and greater thruput, he declared. The United Kingdom Llandarcy plant expansion to 62,800 barrels per day is well advanced, and work to enlarge Grangemouth refinery to 31,400 barrels per day by end of 1950 has begun. Modifications "now in hand" are designed to hike capacity of the L'Avera refinery in France of Societe Generale des Huiles de Petrole to 25,100 barrels per day.

Also agreement has been reached, he said, with Petrofina Company in Belgium to construct jointly a 27,200-barrel-per-day refinery at Antwerp for operation by the end of 1951.

Governor Wright to Speak

Governor Fielding L. Wright of Mississippi will speak on "The Accomplishments of Oil and Gas Conservation in Mississippi," at the summer quarterly meeting of the Interstate Oil Compact Commission in the Stanley Hotel, Estes Park Colo., Sept. 1-3.

Calendar of Meetings

AUG. 15–17	Society of Automotive Engineers West Coast Meeting, Portland, Ore., Multnomah Hotel.
17 Sept. 6	United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success.
SEPT.	
1– 3	Interstate Oil Compact Commission, Quarterly Meeting, Estes Park, Col., Stanley Hotel.
7–10	North American Gasoline Tax Conference, Lake Tahoe, Tahoe Tavern.
11–14	American Standards Association, Annual Meeting, New York, Waldorf-Astoria Hotel.
12–16	Instrument Society of America, National Conference and Exhibit, St. Louis, Municipal Auditorium.
14–15	American Petroleum Institute, Division of Marketing (Lubrication Committee) Atlantic City, Hotel Traymore.
14–16	National Petroleum Association, Atlantic City, Hotel Traymore.
18–20	American Institute of Chemical Engineers, Montreal, Canada, Mt. Royal Hotel.
19–21	National Butane-Propane Association, St. Louis.
24–28	National Safety Council, Chicago, Morrison Hotel.
28–30	The American Society of Mechanical Engineers Fall Meeting, Erie, Pa.
OCT.	
2– 5	American Society of Mechanical Engineers, Petroleum Division, 1949 Petroleum Mechanical Engineering Conference, Oklahoma City, Biltmore Hotel.
3– 4	National Association of Corrosion Engineers, South Central Regional Division, Annual Meeting, Dallas, Adolphus Hotel.
3– 5	National Lubrication Grease Institute, New Orleans, Hotel Roosevelt.
OCT. 5– 7	American Institute of Mining and Metallurgical Engineers, Petroleum Division, Fall Meeting, San Antonio, Plaza Hotel.
7	California Natural Gasoline Association, Los Angeles, Ambassador Hotel.
10–14	American Society for Testing Materials, West Coast Meeting, San Francisco, Fairmont Hotel.
13–14	Texas Mid-Continent Oil and Gas Association, Annual Meeting, Houston, Rice Hotel.
17–20	American Gas Association, Annual Convention, Chicago.
17–21	American Society for Metals, National Metal Congress and Exposition, Public Auditorium, Cleveland, Ohio.
31 to Nov. 4	National Safety Council Congress, Chicago, Morrison Hotel.
NOV. 1– 2	Society of Automotive Engineers, Diesel Engineers, St. Louis, Chase Hotel.
1– 5	Pacific Chemical Exposition, San Francisco, Civic Auditorium.
3– 4	Society of Automotive Engineers, Fuels and Lubricants, St. Louis, Chase Hotel.
7–10	American Petroleum Institute, 29th Annual Meeting, Chicago, Stevens Hotel.
7–10	American Institute of Chemical Engineers, Pittsburgh, Hotel William Penn.
27 to Dec. 2	American Society of Mechanical Engineers, Annual Meeting, New York, Hotel Statler.
28 to Dec. 3	Twenty-second Exposition of Chemical Industries, New York, Grand Palace.
DEC. 4– 7	American Institute of Chemical Engineers, Annual Meeting, Pittsburgh, William Penn Hotel.

Colorado Mines to Observe Seventy-Fifth Anniversary

The tentative program for the Colorado School of Mines three-day commemoration of its seventy-fifth anniversary, September 29 through October 1, includes conferences on the theme, "Mineral Resources in World Affairs," with discussions on the broad field of mineral-industry economics and problems of the mineral industry.

Petroleum refining will be represented in addresses by E. W. Isom, vice president of Sinclair Refining Company, New York, on "Pyrolytic Production of Liquid Fuels"; Harrison L. Hays, chief engineer, process, design, and development division of Phillips Petroleum Company, Bartlesville, Okla., on "Commercial Dehydrogenation of Normal Butane"; Keith Buell, assistant superintendent, chemical engineering department, Phillips Petroleum Company, and L. J. Weber, Phillips Petroleum Company on "Ethylene Production by Thermocracking of Propane and Ethane Mixtures"; H. M. Schmitt, Brown Instrument Company, on "Automatic Processes Control in Petroleum Refining"; and V. F. Parry, chief of United States Bureau of Mines testing station at Golden, on "Low Temperature Carbonization of Rocky Mountain Coals."

Researchers Join Cyanamid

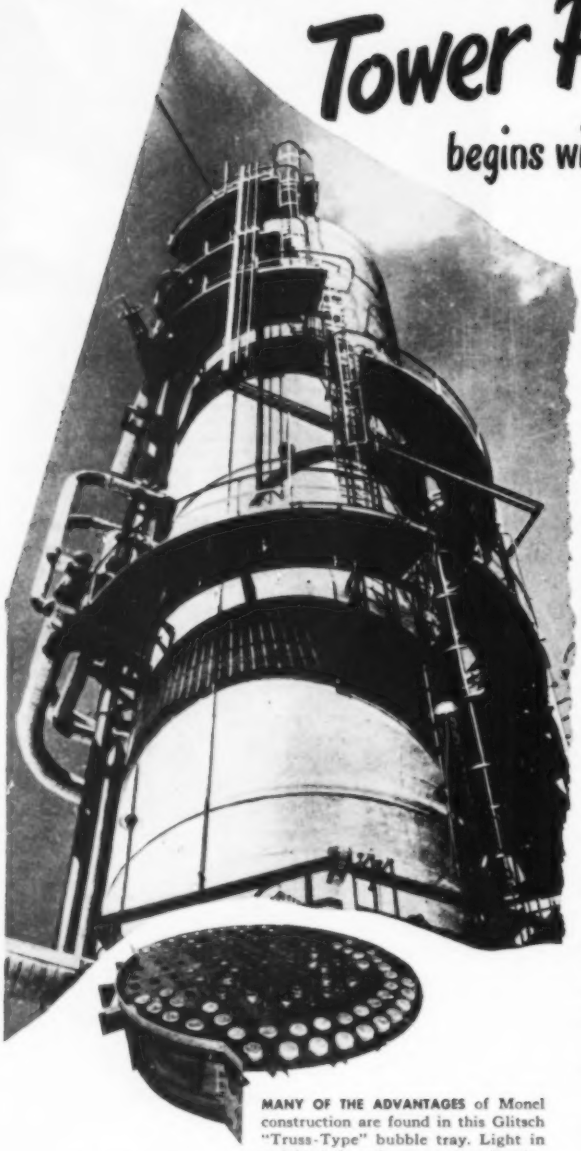
Vincent V. Lindgren and B. R. Putnam, Jr., have joined the new product development department of the American Cyanamid Company. Dr. Lindgren, who has been associated with the company for the past three years in its Stamford research laboratories, will devote his time to new product development activities. Putnam, who has been engaged in engineering development in the company's technical department, will be concerned with market research activities.

Retires from Tide Water

Paul L. Rafford, Roselle Park, N. J., assistant supervisor of the manufactur-

In designing for all types of crudes...

Tower Protection begins with Monel!



MANY OF THE ADVANTAGES of Monel construction are found in this Glitsch "Truss-Type" bubble tray. Light in weight, it is easier to erect and maintain. Monel's ductility eliminates breakage during installation and cleaning... Smooth, corrosion-resistant Monel surfaces increase tower efficiency, reduce coking hazards. And Monel caps and trays, if distorted by explosion, can be readily straightened and restored to service... *This photo used through courtesy of the fabricator, Fritz W. Glitsch & Sons, Dallas, Tex.*

Design engineers seldom know, these days, what the next crude will be like.

Today sweet—tomorrow sour. Or maybe a mixture of both. That's why top sections of fractionating towers need *plenty* of protection against corrosion.

And they get this protection from MONEL*. That has been proved time and again in every refining center.

Just recently, for example, The M. W. Kellogg Company, refinery and chemical engineers of Jersey City, New Jersey, designed a large refinery for charging a sour crude containing in the neighborhood of 2% sulfur. Kellogg knew from past experience that most commercial metals used in the top sections of the fractionating vessels would pit due to corrosive action by sulfur and salt compounds in condensed water vapor.

Consequently Kellogg engineers recommended Monel-lined nozzles for refluxing in top tower sections for temperatures of 400°F. or below. Monel does not pit under these conditions, and Kellogg knew it would display satisfactory resistance to predicted corrosion in the upper tower sections where temperatures below the dew-point are encountered.

Monel, as a matter of fact, is highly resistant to sulfur attack at temperatures up to 500° F. It resists corrosion by sulfuric acid, dilute hydrochloric acid, brines, sour crudes, caustics and chlorinated solvents. Its high strength and low corrosion rate make possible the use of thin, lightweight sections that save you money in both material cost and tower design.

Before you choose a metal for top tower sections, be sure to investigate the advantages of using Monel. Write us for information and technical data now, so you'll have all the facts on hand when you need them.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y. *Reg. U. S. Pat. Off.

EMBLEM OF SERVICE
INCO
TRADE MARK

MONEL...for minimum maintenance and replacement

ing accounting department of the Bayonne refinery, Tide Water Associated Oil Company, retired July 1 after 41 years of continuous service.

Rafford started with the oil company as a clerk at a refinery warehouse in 1908 and became a clerk with the process section of the accounting department in 1923. In 1943 he was promoted to head that section and also to the position of assistant supervisor of accounting.

Blaw-Knox Division Opens District Office in Tulsa

Barry

Baird

Chemical plants division of Blaw-Knox Company has announced expansion of its oil and gas department through additional personnel and the opening of a district office at Tulsa. The new office will be supervised by R. H. Hazlett, department manager, and will provide sales and engineering service to the oil and gas industries of the Southwest.

E. W. Forker, president of the chemical plants division, said that the Tulsa office will also be available for service on chemical plant projects.

Charles B. Barry of Tulsa, has been appointed chief engineer for the oil and gas department with headquarters in Tulsa and Carl E. Baird, originally of Dallas, has been named sales representative for the Tulsa office.

Named Research Club Head

Dr. Howard L. Yowell, a member of the research staff at Esso laboratories of Standard Oil Development Company, has been elected president of the Esso Research Club. Organized in 1942, the Esso Research Club is a social and scientific organization of technical employes of Standard Oil Company (New Jersey) and its subsidiary and affiliated companies. Other officers elected are first vice president, Harry T. Rice and secretary, Herbert L. Minich, both of Esso Standard Oil Company; second vice president, Dr. Carl S. Carlson, and treasurer, Dr. Leonard E. Moody, both of Standard Oil Development Company.

Dickson Safety Group Head

Lawrence E. Dickson, president of Standard Safety Equipment Company of Chicago, has been elected president of the Industrial Safety Equipment Association for the second consecutive year. Charles H. Gallaway, sales manager of American Optical Company's safety products division, was elected vice president of the association, succeeding Walter G. Legge. During the past year, Gallaway served as a member of the planning committee. William J. Parker of William J. Parker, Inc., New York City, was elected secretary-treasurer.

Officials See Need for Hike In Refinery Runs

Interior Department experts see a "necessity" for domestic refiners to increase crude runs within next two months by 400,000 to 500,000 barrels per day to meet an anticipated sharp jump in heating oil consumption this winter. Current runs are dipping heavily into crude oil stocks in storage.

Expressing concern over delayed buying of heating oil by distributors and consumers, the officials declared this is one of the reasons why refiners are not turning out more light fuel oil at this time. Because of the expectation that new heating installations will require a 10 percent hike while normal winter weather will call for additional 10 per cent over last year, the officials estimate that the total demand for 1949 would run about 2 percent higher than in 1948. Total demand last year was 6,129,000 barrels per day, with 5,761,000 barrels per day of this amount identified as domestic demand.

Joins California Texas Oil

Francis E. McIntyre has resigned as assistant director of the Commerce Department's Office of International Trade to become head of economic research for California Texas Oil Company of New York.

Former instructor in economics and principal research officer of the Cowles Economic Research Commission, he entered government service with the Lend-Lease Administration shortly after Pearl Harbor. Later he served as special advisor to the assistant secretary of state and as director of export control for commerce.

Rodman Succeeds Prichard

Roland V. Rodman, president of Anderson-Prichard Oil Corporation, was elected president of Col-Tex Refining Company to succeed the late L. H. Prichard. Neal B. Prichard has also been elected a director to succeed L. H. Prichard who was former chairman of the board, president of Anderson-Prichard Corporation, and president of Col-Tex Refining Company, a corporation jointly owned by Anderson-Prichard Oil Corporation and Standard Oil Company of Texas.

THE MONTH...

N. Y. Purchasing Agents Name Northacker Chairman

Alfred A. Northacker, assistant purchasing agent, The M. W. Kellogg Company, New York, was elected and installed, chairman of the executive board of the Metropolitan Purchasers' Assistants Club of New York City, at their annual meeting held on June 21.

Northacker

Prior to his election to this, the association's highest office, Northacker served two terms as its president.

Lane Succeeds Innis as Sun Marine Administrator

John M. Lane, Jr., has been appointed marine administrator of Sun Oil Company, succeeding Charles R. Innis who retires after almost 40 years service with the company. Lane will coordinate the movements of the company's fleet to meet refinery and marketing requirements and will have charge of chartering tankers and barges. He will work with Charles L. Boyle, manager of the company's marine department, in charge of operations and personnel.

LPG Technical Course

A course in gas fuel technology will be offered, beginning September 26

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1948:									
January 31	5,318	5,434	228,083	15,986	102,973	7,690	40,580	9,141	50,839
February 28	5,387	5,463	226,860	15,796	111,040	7,963	33,836	8,824	49,206
March 27	5,377	5,324	229,409	15,783	112,991	7,682	30,717	8,854	48,334
April 24	5,415	5,517	228,488	16,515	111,128	6,831	34,237	8,877	49,572
May 29	5,452	5,715	228,979	17,827	107,185	7,054	38,641	9,508	55,146
June 26	5,494	5,674	229,632	17,938	104,178	7,200	45,166	8,858	58,812
July 31	5,455	5,718	230,720	17,646	99,116	6,823	56,661	9,080	65,713
August 28	5,529	5,682	226,873	17,722	95,504	7,491	66,321	8,918	70,653
September 25	*5,343	4,789	*234,193	15,100	78,669	5,997	61,884	6,380	37,326
October 30	5,604	5,626	239,702	17,569	91,925	7,679	81,593	8,853	81,299
November 27	5,617	5,721	244,246	17,317	89,802	7,476	85,151	9,477	86,192
December 25	5,641	5,784	250,555	18,178	100,288	7,776	79,271	9,121	86,181
1949:									
January 29	5,493	5,490	255,459	17,531	114,677	7,547	67,432	8,178	84,462
February 26	5,401	5,412	261,965	17,621	124,382	7,430	57,746	8,225	80,246
March 26	5,188	5,353	266,506	17,417	128,087	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,255	17,989	124,787	6,681	49,959	8,185	60,174
May 28	4,951	5,297	273,190	18,324	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	274,114	18,462	115,715	5,148	63,049	7,856	66,146
July 30	4,731	5,187	‡272,107	18,038	109,964	6,293	†70,767	7,205	†67,166

* Total U.S. All other September 25 figures do not include California, due to strike.
† Fuel oil stocks on new basis since March 26, 1949, and not comparable with previous totals.
‡ Crude Stocks: June 18.

60 Million Miles of Fleet Research

COOPERATIVE TESTS, made possible by Ethyl's close relations with automotive companies and operators of commercial fleets, have provided information on more than 60,800,000 miles of road operation. Commercial fleet testing is the final step in Ethyl's extensive research program aimed at developing the best antiknock fluids for the oil industry.

Refiners benefit two ways

In addition to contributing to continually improved antiknock fluids, Ethyl's carefully controlled fleet programs provide refiners two major benefits:

(1) Basic information on the performance of different types of gasolines and oils operating under a wide range of service conditions . . .

thus refiners often find it possible to reduce the amount of expensive fleet research necessary to obtain similar basic data.

(2) A fund of information on improved maintenance practices which often point the way to more satisfactory use of petroleum products.

Although the Laboratories each year conduct thousands of hours of research on single-cylinder engines, on full-scale engines connected to dynamometers, and on Ethyl-owned fleets of passenger cars and trucks at Detroit and San Bernardino, the Laboratories have never been satisfied to accept the results of any one of these steps as conclusive.

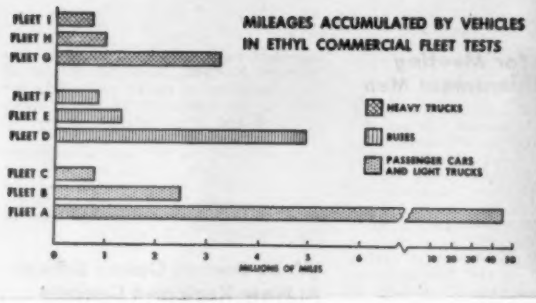
Despite the meticulous care exercised in the conduct of laboratory research programs, uncontrollable variations in engines of the same make and model often introduce extraneous effects. Furthermore, there is always the possibility that actual field service involves variables not included in laboratory studies. Both of these difficulties are met by Ethyl through carefully controlled tests in commercial fleets operated under a wide range of conditions. Ethyl commercial fleet tests are planned to be representative of the types and makes of vehicles in production, the variety of loading and operating schedules normally employed, and the weather and topographical conditions encountered in service in different parts of the country.

The scope of Ethyl's research conducted in commercial fleets is illustrated by the wide variety of problems investigated. Chart at right.

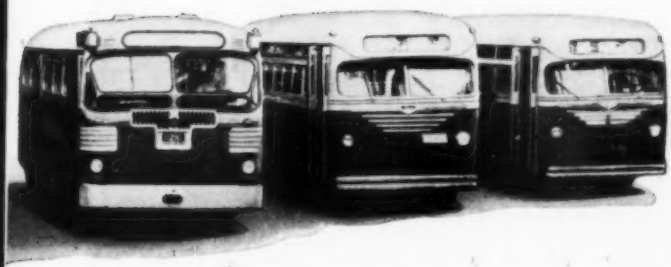
The fleet of the Dayton Power and Light Co. has been used since 1928 in carefully controlled research programs in cooperation with Ethyl.

ETHYL FLEET INVESTIGATIONS

PROBLEMS INVESTIGATED	FLEET A	B	C	D	E	F	G	H	I
BEARING WEAR				▨	▨				
CYLINDER BORE WEAR				▨			▨		
CARBON ACCUMULATED	▨	▨	▨	▨	▨	▨	▨	▨	▨
ENGINE CLEANLINESS									
GASOLINE ECONOMY	▨								
OIL ECONOMY	▨								
OCTANE NUMBER REQUIREMENT									
PISTON RING WEAR									
SPARK PLUG LIFE AND PERFORMANCE	▨	▨							
VALVE LIFE AND PERFORMANCE	▨	▨							



Determinations of valve seat run-out (left) and cylinder bore diameter (right) are typical of the "before and after" measurements done on fleet units . . . both accomplished with the aid of equipment specially developed by Ethyl.



Under the close supervision of experienced Ethyl engineers, valuable information on the performance of fuels and crankcase lubricants in commercial vehicles has been obtained in large city bus operations.

How this Ethyl fleet research is conducted

In the conduct of an Ethyl commercial fleet test, comprehensive control of the entire research program is the responsibility of an experienced Ethyl engineer assigned to the project. He works out the details of the test with the management of the fleet so that vehicle operation proceeds in a normal and satisfactory manner. He also is responsible for making certain that procedures and controls provide reliable data . . . without introducing changes in the operation which would destroy the usefulness of the fleet as an index of commercial operation. Mechanical work on engines, vital to the conduct of the test, is often performed by specially trained mechanics from the Ethyl Laboratories.

The uniformity of fuel quality required during a test program sometimes necessitates the installation of additional fuel storage tanks and of equipment for mixing "Ethyl" antiknock compound with base gasoline. Many of the special instruments and forms developed by the Ethyl Laboratories for use in their own road test operations are employed in commercial fleet tests. Frequently the Laboratories purchase, break in and prepare new engines for installation in the test fleet. At the conclusion of the research program, these engines are removed from the vehicles and returned to the Laboratories for extensive inspection, measurement and photography.

Ethyl has developed many special technical forms to record data obtained in fleet tests.

This message is the sixteenth in a series dealing with problems faced by refiners in producing gasoline for today's and tomorrow's engines, and the contribution of the Ethyl Corporation to their solution.

SINCE 1923—Continuous Research to Provide Better Antiknock Service

ETHYL CORPORATION

RESEARCH LABORATORIES

DETROIT, MICHIGAN . . . 1600 WEST EIGHT MILE ROAD

SAN BERNARDINO, CALIFORNIA . . . 2600 CAJON ROAD

THE MONTH . . .

through the next 18 months, by Southern Technical Institute, a unit of Georgia Institute of Technology at Chamblee, Ga. Developed with the cooperation of Liquefied Petroleum Gas Association, the study will be open to graduates of accredited high schools. The course will offer specific training in gas operations, technical and supervisory training. For a descriptive catalog write Southern Technical Institute, Chamblee, Ga.

Deceased Texas Governor Active in Oil Industry

Beauford H. Jester, 56, governor of Texas, died July 10 in Houston. Prior to his election as governor, Jester had served as a member of the Texas Railroad Commission.

Jester

A graduate of the University of Texas and the Harvard University Law School, Jester practiced law in Corsicana, Texas. His career was closely connected with the oil industry during the boom years in the Corsicana fields.

Jester was appointed to the board of regents of the University of Texas in 1929, and later became chairman of the board. He also was prominent in activities of the Interstate Oil Compact Commission.

Readjust to ECA Goals, Levy Tells Oil Industry

If Europe achieves recovery with American financial aid and "if the U. S. oil industry adjusts itself to realities of the situation," then the lot of American oil in world markets, while most difficult, will not be disastrous as it sometimes is feared. This was the view given last month by Walter J. Levy, chief of the petroleum branch of Economic Cooperation Administration. The Marshall Plan's top expert added that the Marshall Plan is giving American oil exporter time to evaluate a "world-wide dollar problem which threatens his very existence" and time to take steps to solve.

Expansion of European oil facilities to cover an increasing part of domestic needs and also to expand export markets, Levy asserted, can be justified only to the extent that the output from such facilities can be sold without the use of discriminatory trade or currency practices and without the utilization of other restrictive trade devices.

In deploring bilateral trade arrangements, he said that the recent commercial agreement between Argentina and United Kingdom may close the Argentine market to American oil during the next five years. And, he continued, the Argentine oil market, once lost, may be hard to regain. He added that he is continuing discussions with the British and Dutch officials in the effort to get them to scale down ambitious plans for refinery expansion.

Buffalo Site for Meeting In 1950 of Instrument Men

The board of directors of the Instrument Society of America has selected Buffalo, N. Y., for the 1950 instrument conference and exhibit with the technical meetings and exhibit being held in the Buffalo Auditorium, September 11 to 15.

St. Louis has the 1949 meeting, to be preceded September 9-12 by a clinic on the maintenance of industrial instruments scheduled in the Statler Hotel.

This year, September 12 through 16, the co-sponsoring societies have arranged a program of 75 papers to be presented in 26 sessions.

The society will hold sessions on instrumentation for production processes, inspection and gauging, maintenance and operation of instruments, instruments in transportation, instruments in testing, and instruments in chemical analysis. The American Society of Mechanical Engineers, Industrial instruments and regulators division, and the American Institute of Electrical Engineers, instruments and measurements committee also will be represented.

Brown Training School Plans Industrial Courses

A 13-week course and two five-week courses have been scheduled for the period from August 15 to December 2 by the Brown Training School of Industrial Instrumentation, Brown instruments division of Minneapolis-Honeywell, Philadelphia. The courses, designed primarily for customers, will cover millivoltmeter type pyrometers, mechanical potentiometer pyrometers, continuous balance electronic type potentiometers, electrically operated automatic control, flow meters, thermometers, pressure gauges, hygrometers, air operated automatic control, moist-o-graphs, tachometers, resistance thermometers, CO_2 and analygraph.

Advisory Board Selected For Maintenance Exhibit

A fifteen-man board, has been selected to act as an advisory group for the first Plant Maintenance Show to be held in the Cleveland, Ohio, auditorium, January 16-19. L. C. Morrow, editor, "Factory Management and Maintenance," will be general chairman of the advisory board as well as of the four-day conference, called "the first ever devoted exclusively to maintenance problems."

Major stress at both the show and conference will be placed on cost reduction factors. Some of the equipment, services and materials to be exhibited will include the fields of air conditioning instruments, meters, gauges, employee relations, training and safety, maintenance tools and supplies, electrical equipment, management consultants and services, welding and gas cutting.

Newcomb Retires from Esso

Franklin LeRoy Newcomb, a design consultant specializing in equipment safety in the Esso Engineering Department of the Standard Oil Development Company, research affiliate of Standard Oil Company (New Jersey), has retired after nearly 32 years service. Author of articles on refinery inspection procedures and equipment, which appeared in PETROLEUM REFINER, Newcomb is one of the originators of metals and safety inspection on equipment of the refining industry and is recognized as one of the authorities in this field.

He received his mechanical engineering degree from Cornell and with the exception of a year's service with an affiliated company in South America, all of his company service has been in the Elizabeth, N. J., area.

W. M. Barnes Opens Offices In New York and Canada

Underwood

Nelson

W. M. Barnes Company has opened new company offices at 654 Madison Avenue, New York and at 10053 Jasper Avenue, Edmonton, Alberta, Canada. The latter office will be known as W. M. Barnes Company of Canada, Ltd.

The New York office will be under the direction of H. W. Nelson, recently appointed vice president of the Barnes Company. Nelson is also president of H. W. Nelson Company, an organization that has been primarily engaged in railroad construction since 1910.

The office at Edmonton will be managed by Fred J. Underwood who was the project manager in charge of erection of the refinery just completed by the Barnes company for Imperial Oil Company, Ltd. at Edmonton.

Octane Ratings Improve

For the third consecutive winter, octane ratings of regular and premium-priced gasolines sold in service stations of the United States showed improvement over the previous year, according to the 1948-49 semi-annual survey of motor gasolines released by the Bureau of Mines.

The Bureau report showed that regular price gasoline had an average octane rating of 75.6 during the past winter, compared with 75.3 for the previous winter. Premium price gasoline had an average rating of 79.7, compared with 79.4 for the winter before.

Coal Test Run Successful

A successful full scale run was made last month in the Bureau of Mines' new coal gasification unit at Louisiana, Mo.

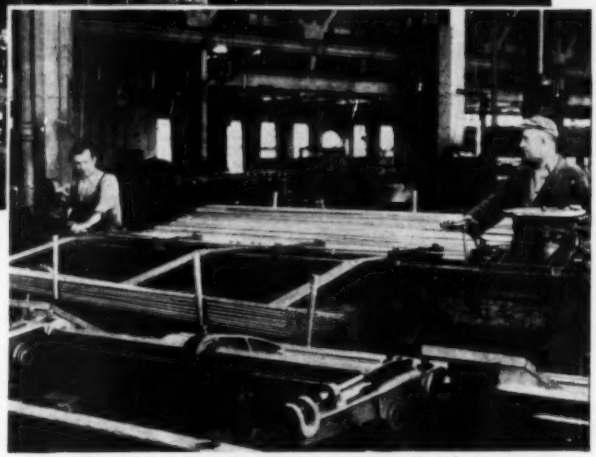
As a part of the Bureau's gas synthesis (Fischer-Tropsch) demonstration plant, this coal gasifier is the second of the plant's five units to be completed. An oxygen production unit has been in operation for several months, and it is anticipated that the remaining units for gas purification, hydrocarbon synthesis, and product refining will be finished and in operation during 1950.

The new type continuous gasifier, in-

ARSENICAL ADMIRALTY 439

today's standard, designed for long-life in refinery service

Amount of critical alloying elements is checked in the laboratory with the help of this grating-type spectograph.



Every Anaconda Condenser Tube must withstand the hydrostatic pressure test required by A.S.T.M. Specification B 111.

CONTAINING approximately 70% copper, 28.96% zinc, 1% tin and 0.04% arsenic, Arsenical Admiralty 439 is highly resistant to dezincification, general corrosion, attack by fresh, brackish or salt waters, sweet or sour crudes under pressures, velocities and temperatures normally encountered in refinery condensers and heat exchangers.

Several years of extensive research preceded the commercial production of Arsenical Admiralty Tubes which was begun in 1934. The consistently satisfactory performance of Arsenical Admiralty Tubes in crude and re-run stills, cracking and polymerization plants for the past 15 years has fully proved the effectiveness of arsenic as an inhibitor of dezincification and has fully substantiated laboratory test results.

TECHNICAL SERVICE AVAILABLE

It is a function of the engineers of our Technical Department to assist tube users in the selection of the most economical alloy for any given set of operating conditions. Feel free to call on us. Publication B-2, giving detailed information on Tubes and Tube Sheet Alloys mailed on request. 48141

ANACONDA

Anaconda

HEAT EXCHANGER TUBES

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

CUT PUMPING COSTS

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Evans, McCollum Promoted

Evans

McCollum

Continental Oil Company has appointed George W. Evans to the newly created position of coordinator of pipe lines and manager of purchasing and S. V. McCollum as purchasing agent.

Evans joined Continental in 1922 and was named general purchasing agent in 1939.

McCollum, no relation to Conoco's president, joined Continental in 1939 as a roustabout. He was named regional petroleum engineer at Fort Worth in 1947 and was promoted to assistant purchasing agent at Ponca City in 1949.

Deep Rock's Research Staff

Deep Rock Oil Corporation is establishing a research staff headed by Dr. Nils K. Anderson, former associate professor of chemical engineering at Northwestern University. He has become associated with the company as director of research and development. Dr. Delton R. Frey, appointed manager of products application, and Jesse B. Jackson Jr., also have been assigned to research.

King Becomes Manager

F. C. King has been appointed assistant manager of General Petroleum Corporation's engineering department. King is a native of Toledo, Ohio, and a 1935 graduate of the California Institute of Technology. He joined the General Petroleum Corporation in 1941 as an inspector, and became refinery engineer in 1946. Since then he has worked at the company's Torrance, Calif., refinery chiefly on maintenance engineering.

Bothwell Gulf Director

E. C. Bothwell has been elected a member of the board of directors of The Gulf Oil Corporation and also a member of the company's finance committee. He succeeds John E. Nelson, director and executive vice president who is retiring. K. C. Heald will continue to assist Bothwell with overseas operations.

Bruce Brown to Head New Merged Company

Merger of Pan American Petroleum Corporation of New Orleans with its subsidiary, Root Petroleum Company of Shreveport, La., to form Pan-Am Southern Corporation has been voted by directors of the two merging companies. Ratification by stockholders is to be sought at special meetings August 23.

Brown

President of Pan-Am Southern Corporation will be Bruce K. Brown, who is now president of Pan American Petroleum Corporation and vice president and director of Standard Oil Company (Indiana). Dwight F. Benton, president of Root Petroleum Company will be advanced to another position with Standard Oil Company (Indiana), the parent company, upon consummation of the merger, according to A. W. Peake, president of Standard Oil Company (Indiana).

Pan-Am Southern Corporation will be headquartered in the Pan-Am building at New Orleans. Its crude exploration, producing, purchasing, and pipeline activities however will continue to be directed from Shreveport, where the principal office of Root has been located. The two refineries of the company are at El Dorado, Ark., (Root) and Destrehan, La. (Pan-Am).

Jefferson Chemical Names New Austin Lab Directors

Dr. William J. Peppel has been appointed director of Jefferson Chemical Company, Inc.'s, new Austin, Texas, laboratories and Charles H. Novotny has been named manager. Dr. Peppel will be in charge of all technical activities, while Novotny will be responsible for general management including construction, purchasing, services and public relations.

Assisting Dr. Peppel in the direction of the Austin divisions will be: John W. Waldron, assistant director of the laboratories and director of the process development division; Dr. J. David Malkemus, director of the products application division; Granville W. Burtt, director of the analytical and testing division; and Martin M. Padwe, librarian in charge of the library and abstracting division. A director for the chemical research division has not yet been named.

These appointments are effective immediately although the laboratories, where all of Jefferson's research and process development work will be consolidated, will not be formally opened until later in the year.

Males Retires from Co-ops

O. B. Males, superintendent of the refinery division of Saskatchewan Federated Co-operatives Limited, Regina and Saskatoon, Can., has retired from the company. B. W. Pawson, assistant superintendent, will succeed him.

Males joined the co-operatives of Saskatchewan in 1935 to design and erect the world's first co-operative refinery known at that time as the Consumers' Co-operative Refineries Limited. Males has been in oil refining since 1908. He spent some time in Japan prior to World War I and has been employed in Canada since 1932.

New Line Delivers Crude To Wood River Refinery

Called "the largest privately-constructed pipe line ever built in America," the Basin-Ozark systems on July 15 delivered the first barrel of crude into Shell Oil Company's refinery's new tank farm at Wood River, Ill. The 20 to 24-inch diameter line which stretches for 1000 miles from New Mexico to Wood River, will help move "huge quantities of oil from the Southwest to the growing Midwest markets," Shell officials said.

Hallanan of NPC Blasts Attacks on Big Business

NPC Chairman Walter S. Hallanan last month in an address said that it is not a government function to destroy organizations of business just because they are big and integrated.

Hallanan recognized the necessity of government protection of small operators from "unfair and destructive competition," but said that America has more to fear from the "giant of government" than from big business. He cited Great Britain as a victim of socialist-managed economy.

Referring to the construction of the Basin and Ozark Pipe Line Systems, he pointed out that some of the tasks faced by big business are so enormous in their demands upon capital, labor and technological skill that giant corporations must combine forces to get the job done. The Texas, Shell, Sinclair and Empire Oil Companies were behind the construction of Basin and Ozark systems.

Sinclair Elects Executives

Sinclair Refining Company has elected C. J. Allen vice president and I. J. Bergholt assistant treasurer. Allen joined the Sinclair Company in 1921 at Albany, New York. In 1926 he came to the New York office, and in 1946 was elected assistant treasurer, which position he still holds. Bergholt joined the Sinclair Company in 1933 at Warren Pennsylvania and moved to New York in 1939. In 1942 he was elected treasurer of the Sinclair Rubber Company at Houston, Texas, returning to the New York office in 1945.

NGAA Regional Meets

The Natural Gasoline Association of America has scheduled regional meetings at Tyler, Texas, on October 14 and at Amarillo on December 9.

Nelson to Retire from Gulf

John E. Nelson, executive vice president of Gulf Oil Corporation plans to retire, effective September 1, after 42 years with the company. Nelson is a director, a member of the executive committee, secretary of the finance committee, chairman of the annuity and the service award committees, a member of the budget, the authority for expenditure, and the policy planning commit-

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tees. Under his direction, too, are the Gulf Building, (Pittsburgh), communications, and insurance departments. He joined Gulf Oil Corporation in 1908 as secretary and assistant treasurer to W. L. Mellon. He has been associated with the Mellon interests for 47 years.

Monsanto Chemical Names C. H. Sommer and D. L. Eynon

Charles H. Sommer, Jr. and David L. Eynon have been appointed assistant general managers of organic chemicals division of Monsanto Chemical Company. Eynon, who has previously been production manager for the company's plants at Monsanto, Ill., and Nitro, W. Va., will be succeeded by Paul G. Marsh, production manager of the two plants.

Sommer has been assistant coordinator of sales for the company.

Corrosion Engineers Meet

The sixth annual conference of the National Association of Corrosion Engineers, in St. Louis, April 4-7, 1950 will include round table discussions on general corrosion problems and pipe line corrosion, refrigeration, air conditioning and food industry.

Rejoins Standard-Vacuum

Horry F. Prioleau is planning to rejoin Standard-Vacuum Oil Company shortly as a director and vice president. Now senior vice president and a director of Creole Petroleum Corporation, he had been general manager of a Standard-Vacuum subsidiary in The Hague prior to the war.

Prioleau

A native of Charleston, S. C., and a graduate of the University of Virginia, Prioleau has been associated with the petroleum industry in the United States and abroad since 1921. He went to The Hague in 1929 and became general manager there for Standard-Vacuum Petroleum Maatschappij in 1934. He returned to the domestic oil industry and joined Creole Petroleum Corporation in 1943 as assistant to the president and later was elected a vice president and director of that company in 1944.

Plant Construction Notes

"REFINERY and Other Plant Construction" tabulation which occupies six pages commencing on page 81 in this month's issue is a regular feature which has proved invaluable to PETROLEUM REFINER readers. Hundreds of extra copies are called for and used each month. Over the two years which it has appeared, it has filled a very definite need in the processing industry.

To the end that the tabulation appears correct and complete each month, readers are asked to 1) send in "boxscore" data (as called for by the column headings) on projects not listed; 2) furnish details which are missing in any item in the current tabulation and 3) report from time to time on the progress of these projects.

A continuous effort by questionnaire, etc., is made to keep all "boxscore" data up to the minute, but it is only through the active cooperation of company officials and other individuals in the oil industry that we will achieve this goal.

Address Editor, Petroleum Refiner, Box 2608, Houston 1, Texas.

Plant Construction Notes follow on this and succeeding pages.

Revamping Work to Start Soon at Pan American

Pan American Refining Corporation's modernization program at Texas City may be resumed fairly soon, President William A. Moore was quoted as saying on a Texas visit last month.

The "revamping" program which was suspended the first of the year, won't have any material effect on the refinery's throughput, but will have a substantial effect on operating efficiency and improved yields, he declared.

Runs at the Texas City refinery in general are off about 10 percent from last year's throughput of 105,000 barrels daily, a reflection, Moore said, of the industry's postwar readjustment.

Refinery Plans Approved

The Dominican Republic has approved plans for construction of a refinery which will meet the total petroleum needs of the country, 2500 barrels per day currently, and provide a surplus for export.

Eventual capacity of the refinery will be 25,000 barrels per day. The $6 million initial installation will process 5000 barrels per day and final construction will include a plant to refine aviation gasoline. The Republic will import crude which it does not presently produce.

Eco Advisors Council Sees Refining Modernizing Needs

Oil refining equipment is among some important classes of capital goods in which there now exists a special backlog of deferred replacement needs, according to a discussion sent to Congress along with President Truman's midyear economic report. These needs arise from the unusually high proportion of over-age units in service.

"For (a maximum employment and production) the economy's present capacity in general is now no more than adequate," the report continues, "and in some industries is distinctly inadequate. Continued long-run economic growth will call for further expansion of productive capacity, though quite possible not at as rapid a pace as in the first postwar year. Moreover, there is no definite ceiling on the amount that might be spent continuously, under favorable conditions, for modernization of facilities."

THE MONTH...

Products Lines Will Serve Plant at Salt Lake City

Salt Lake Pipe Line Company, a wholly-owned subsidiary of Standard Oil Company of California, has issued calls for construction bids on the initial portion of a $12 million pipe line to be built from Salt Lake City into the northwest. The 560-mile line has been designed to carry oil products such as two grades of gasoline, heating and diesel fuels which are manufactured at Standard Oil Company of California's recently constructed Salt Lake refinery. The line will also serve bulk storage plants along its route into the Northwest.

Construction, which will include a pumping station at the Salt Lake refinery, is to be started as soon as possible, with the 320-mile line to Boise expected to be completed before the end of the year. Plans indicate that later the line may be expanded northward from Boise to a terminal in western Washington on the Columbia River.

General Petroleum Adds To Capacity of Refinery

General Petroleum Corporation has started construction on a $2.25 million expansion project at its Torrance, Calif. refinery to turn more surplus heavy fuel oil into other petroleum products in greater demand. The new facilities will add 50 to 80 percent to the refinery's ability to take light hydrocarbons contained in the fuel oil, leaving only solid coke. Completion is scheduled for early in 1950.

General's existing unit has four coke drums, each 17 feet in diameter and 80 feet high, lined with stainless steel. Additional components include a fractionating tower, furnaces, heat exchangers, and de-coking equipment. The expansion project will add two more coke drums and another furnace. The other portions of the existing unit are being revised to permit them to handle the greater charge.

Design engineering for the expansion project is being done by the M. W. Kellogg Company. It will be constructed by The Bechtel Company.

Union Oil to Let Contract

Union Oil Company of California is planning to let contracts for construction of its $40 million two-year refinery expansion program. The new plants will make the heavier part of the crude oil into more saleable products like coke, officials declared. Location of a new coke plant has not been chosen, but it is thought it will be Los Angeles or Santa Maria.

Sohio Plans Modernization

A catalytic cracking plant, the first of three major projects in the $30 million expansion and modernization program of The Standard Oil Company (Ohio)

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THE MONTH . . .

at its refinery at Lima, will go into operation in October. Arthur G. McKee Company of Cleveland is the builder.

The second unit of the expansion program, the combination continuous crude distillation and coking unit, costing $5.5 million. The M. W. Kellogg Company, contractors, is expected to go into operation in February, 1950. The third project is the $1.3 million solvent refining plant for lubricating oils with a daily capacity of 76,000 gallons of finished solvent refined lubricating oil.

The five units of the new Lima lubricating oil plant will provide vacuum distillation, solvent de-asphalting, solvent extraction, solvent de-waxing, and clay treating. The solvent de-asphalting unit will be built by The M. W. Kellogg Company and the other four units of the plant by The Lummus Company.

Continental-Sunray Plan New Gas Compressor Plant

Construction of a gas compressor plant with 12 million cubic feet per day capacity near Nordheim, DeWitt County, South Texas, is planned by Continental Oil Company, Sunray Oil Corporation and others. The plant, which is to serve the Slick-Wilcox field in DeWitt and Goliad counties will include a complete gas gathering system and will consist of four 600-hp. compressor units. Estimated cost of the project is approximately $1 million and work is expected to be completed by the end of this year.

Approximately half of the gas handled by the plant will be returned to producing formations and the remainder will be sold to a gas transmission company.

Carter to Open Refinery

Governor John W. Bonner of Montana will be principal speaker at the formal opening August 26 of The Carter Oil Company's new 20,000-barrel-a-day refinery at Billings Mont. The company is an affiliate of Standard Oil Company (New Jersey).

This new plant is of the latest type of manufacturing equipment and engineering design, capable of putting into operation recently developed practices in refining technology. The Carter Oil Company recently closed its old Billings refinery, which had a capacity of 9000 barrels daily. O. C. Schorp, president of the company, explained that the old refinery equipment was obsolete.

Lone Star Postpones Plans

Lone Star Gas Company's proposed project for the enlargement of its Pueblo gasoline plant, located approximately 12 miles north of Cisco, Texas, has been postponed due to the "present unfavorable market for liquefied petroleum gas, until more stable conditions warrant its reconsideration."

West Texas Plant Begun

Preliminary work has begun on the construction of a $6 million natural gasoline plant for the Dollar Hide pool of southwestern Andrews County, West Texas Permian Basin. The Pure Oil

THE MONTH...

Company will be operator of the plant, jointly owned with Magnolia Petroleum Company, Humble Oil & Refining Company, Union Oil Company, Lion Oil Company, Pacific Western Oil Corporation, F. G. Blackwood, John W. Nichols and W. W. Whiteman, Jr. of Oklahoma City.

The plant will have a capacity of 22 million cubic feet daily. Compressor facilities are scheduled for completion by January 1, and the plant is to be in operation by July 1, 1950.

Gulf-Anglo Iranian Plan Refinery Near London

Anglo-Iranian Oil Company and Gulf Oil Corporation are working out a plan for construction and operation of a refinery on the Isle of Grain in the Thames river, 60 miles east of London.

The refinery, which will cost $120 million, is to have a daily capacity of 60,000 barrels and should go on stream by the middle of 1952. Work already is under way, water well drilling and road construction being well advanced.

It is expected that Anglo-Iranian will own about 75 percent of the stock and Gulf about 25 percent.

Stacey-Dresser Builds Hoosier Desulfo Unit

Stacey-Dresser Engineering is building a desulfo unit for Hoosier Gas Corporation in Vincennes, Ind. It is expected to be in operation in September and will process up to 3 million cubic feet of gas per day, reducing the hydrogen sulphide content of the gas to one grain per 100 cubic feet.

FPC Authorizes Gas Plant

The Federal Power Commission has granted the request of Chicago Pipe Line Company to construct a $6 million plant near Chicago in Will County, Ill., for the purpose of storing natural gas in liquid form during warm-weather months for use during periods of peak winter demand.

FPC says the plant will have a storage of 400 million cubic feet of gas and will contain facilities for liquefying about 4 million cubic feet of gas daily and for regasification and return to the transmission system of 6 million cubic feet per hour.

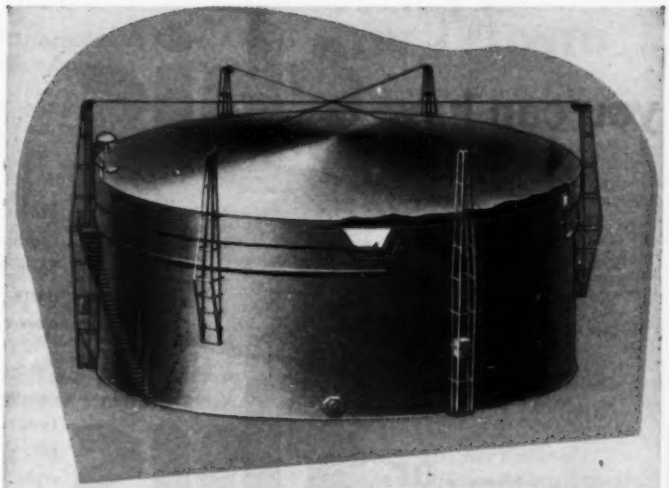
Brazil Plans Refinery

With now-frozen francs, the Brazilian government plans to buy steel in France for a 45,000-barrel-per-day refinery, according to Wingate Anderson, president of Standard Oil of Brazil. The projected plant, to be built either at Rio de Janeiro or Sao Paulo, probably would not be on stream for several years.

The Bahia refinery is being increased in capacity from 2000 to 5000 barrels per day.

Humble Contract to Bellows

Humble Oil & Refining Company has let contract to W. S. Bellows Company for the construction of an estimated $1



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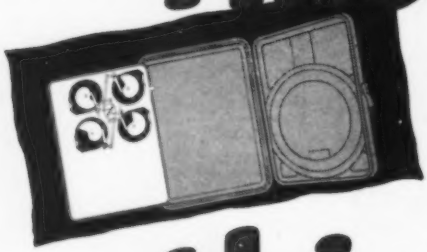

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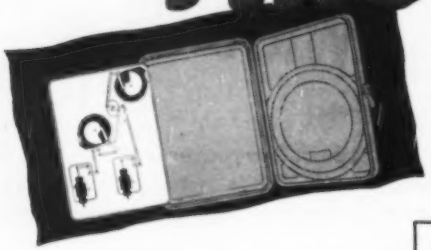

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Arthur G. McKee Orders So Far Equal '48 Period

Dollar volume of new work for the year to date equals that for the corresponding period of 1948, H. R. Moorhouse, secretary of Arthur G. McKee & Company, said in a recent letter to stockholders. "If the number of promising inquiries in prospect materialize soon, the year's volume of new work might well keep pace with that of last year," he declared.

For the next several years, Moorhouse said, the source of much of the company's new work in the refining industry in this country will probably consist of additional catalytic cracking plants and their attendant facilities for making higher quality gasoline, and the replacement of worn out and obsolete crude oil processing units.

Hanna Dies in New York

D. J. Hanna, 53, a vice president and a director of The Bahrein Petroleum Company Limited and California Texas Oil Company, Limited, died suddenly July 26 in New York. In the oil industry since 1916, Hanna served as superintendent of the Richmond refinery and later became a vice president of California Arabian Standard Oil Company.

Morse Killed in Crash

Charles Hosmer Morse, III, vice president in charge of manufacturing, Fairbanks, Morse & Company, Chicago manufacturers, and eldest son of Colonel Robert H. Morse, president of the company, was killed when the company's two motor plane crashed near Roanoke, Ill., Saturday morning, July 9.

"Hos," as he was called, had been connected with Fairbanks, Morse & Company since 1919.

Lyon Dies at Long Beach

Thomas P. Lyon, 76, former assistant treasurer of Cities Service Company, died suddenly July 26 at Long Beach, Calif. Lyon held positions with Denver Gas & Electric Company and other Cities Service Company affiliates prior to his transfer to New York in 1912. He had served as assistant treasurer of Cities Service Company since 1923 until his retirement in 1947.

A. M. Foute Dies

A. M. Foute, who had been associated with Mission Manufacturing Company, Houston for 24 years, died June 29 at his home. Foute, 62, had been secretary of Mission Manufacturing Company since its incorporation in December, 1925.

E. J. Bouwsma Dies

Edward J. Bouwsma, president of Commonwealth Pipe Line Company and Old Dutch Refining Company, Muskegon, Mich., died July 10 in Holland, Mich., after an illness of several months.

Operation Is Started of Bee County, Texas, Plant

The new Burnell-North Pettus plant, a joint project of Stanolind Oil and Gas Company and others, has begun operations five miles northeast of Pettus in Bee County, Texas. It will produce more than 285,000 gallons of liquid products daily when operating at capacity of 166 million cubic feet every 24 hours. The company's staff supervised engineering design and construction of the installation and will operate it for the group of owners. Jones and Laughlin Supply Company of Tulsa was the contractor.

A. Clarence Andrews, formerly field project engineer has been named superintendent.

Indiana Farm Bureau Plans Mount Vernon Cracker Unit

The Indiana Farm Bureau Cooperative Association, Inc., will install a fluid catalytic cracking unit in its refinery at Mount Vernon, Ind. The unit, with a nominal capacity of 4000 barrels of fresh charge stock per day, is being engineered and designed by Universal Oil Products Company and constructed by the refinery's own forces. Materials will be purchased by Franklin Supply Company.

It is estimated that the projected installation, operated with a 2-coil thermal cracker will produce approximately 71 volume percent on crude charge of 10-pound Rvp., 400° F. end point gasoline. The projected operation will also make a 20 percent reduction in the refinery's over-all No. 6 fuel oil production by operating a portion of the capacity of the existing 2-coil thermal cracker as a viscosity breaker, charging the reduced crude from the vacuum flashing unit.

ECA to Finance Aquila's Italian Lube Oil Project

For the first time under the Marshall Plan program, Economic Co-operation Administration has agreed to underwrite an oil equipment purchase deal for a European country. Involved is a $7.95 million project for rehabilitation of warbombed lube oil manufacturing facilities and for installation of a new reforming unit at the Trieste, Italy refinery of Aquila, A.p.a. Technico Industriale. Of total cost, $4.25 million will be financed out of ECA funds, largely for equipment purchases in the United States, and the balance out of local currency. ECA reported the lube plant would have a capacity of 610 barrels per day and that the reforming unit would be used to improve octane value of gasoline base stocks.

The refinery is Italian-owned, with Fiat Company the major share holder. Nearly destroyed by bombs, it resumed operations in June 1947 and at the present has a crude thruput capacity of 12,000 barrels per day.

Italian Refinery Under Way

The Inter-Ministerial Commission of the Italian Government has approved the details of the Condor refinery at Milan and construction is underway. It is expected to be one of Italy's most important refineries with an estimated annual capacity of over seven million barrels. High-octane gasoline, white spirit, kerosine, gasoil, diesel oil and other types of fuel oil will be produced. The site which is about 30 miles from the Swiss border is near Rho on the northwest outskirts of Milan and is in the immediate vicinity of the recently discovered Italian oil fields. The refinery, situated in the center of the province of Lombardy, will have within a 20-mile radius about 15 percent of the Italian markets for petroleum products. The 100-mile, 10-inch pipe line being built to bring the crude oil supply from Genoa will have an annual capacity up to 14 million barrels.

Condor, an independent company, will have close relations through its shareholders and board, with Manchester Oil Refinery Limited in England and with Aquila S.P.A.T.I. in Trieste, the only other independent refinery in Italy.

OIIC Plans for Future, Contributions Being Sought

The Public Relations Committee of the API board of directors meeting with the Oil Industry Information Committee has agreed that the oil industry's public relations program will be continued through 1950 under its present organization but with closer relationship between top oil company executives and the OIIC.

OIIC itself will be reconstituted in 1950 with the addition of district chairmen as full members, by expanding the committee to 35 and providing closer relationship between national and field activities.

It was also voted that OIIC should make an oral report at least twice a year to the API public relations committee and that from two to five members of the API committee will meet with OIIC at each of its future sessions. They will serve as liaison contacts with the full board.

Money to cover the current year's $1.5 million OIIC budget is being asked by L. S. Wescoat, head of the group soliciting contributions. He said that nearly 5000 oil men are actively engaged on a volunteer basis in the work of district, state and local industry information committees.

Checks in support of the program should be addressed to Lacey Walker, Treasurer's Office, American Petroleum Institute, 50 West 50th Street, New York 20, where the funds are being handled for the committee.

United Nations to Hold Conservation Conference

The United Nations Scientific Conference on the Conservation and Utilization of Resources, authorized by decisions of the Economic and Social Council of the United Nations, will be held at Lake Success August 17-Septemper 6. The conference, which is the first of its kind ever held, is part of United Nations program to provide technical assistance to under-developed countries on new methods of using untapped resources to build up their economies. It will be devoted to an exchange of ideas and experience on the techniques of resource conservation and utilization, their economic costs and benefits and their inter-relations.

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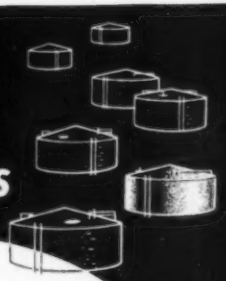

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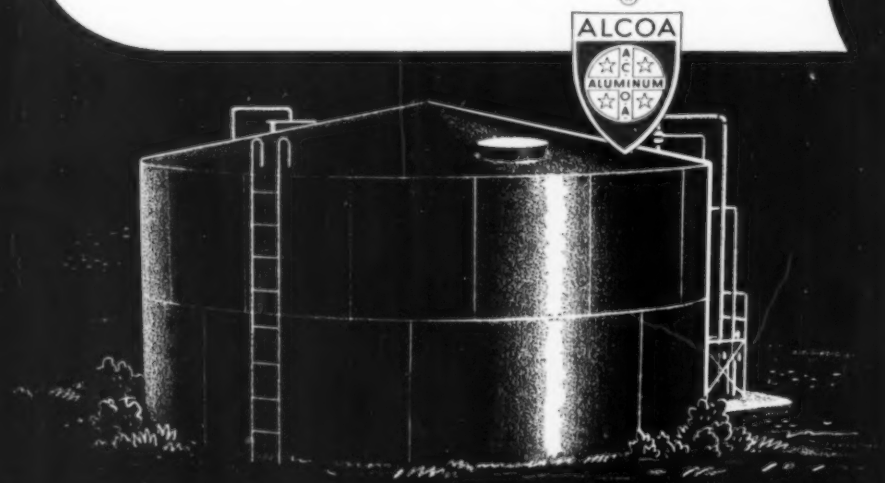

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Fundamental Physical and Chemical Data

Vapor Pressures of Naphthalene Anthracene and Hexachlorobenzene in a Low Pressure Region. G. W. SEARS AND E. R. HOPKE, *Jour. Am. Chem. Soc.* **71,** (1949) pp. 1632-4.

Vapor pressures of naphthalene, anthracene and hexachlorobenzene were measured in the region 0.01-1.0 mm. by a Rosebush manometer. The data were fitted to vapor pressure equations. Only in the case of naphthalene was a quantitative comparison with previous data in the literature possible. In that case the agreement was satisfactory.

Heats of Combustion and Isomerization of the Six C_7H_{14} Alkylcyclopentanes. W. H. JOHNSON, E. J. PROSEN, AND F. D. ROSSINI. *J. Research, Natl. Bur. Standards,* **42** (1949) pp. 251-5.

Heats of isomerization of the six C_7H_{14} alkylcyclopentanes were determined in the liquid state at 25° C. using values previously reported for heats of combustion and formation. Values were calculated for the heats of combustion and formation of the five dimethylcyclopentanes in the liquid and gaseous states at 25° C.

Cyclooctatetraene: Low - Temperature Heat Capacity, Heat of Fusion, Heat Vaporization, Vapor Pressure and Entropy. D. W. SCOTT, M. E. GROSS, G. D. OLIVER AND H. M. HUFFMAN. *Jour. Am. Chem. Soc.,* **71** (1949) pp. 1634-6.

The heat capacity of cyclooctatetraene was measured from 12 to 330° K. The triple point (268.48 0.05° K) and the heat of fusion (2694.6 ±.5 cal./mole) were determined. Vapor pressures were measured over the temperature range from 0 to 75° and an equation is presented to fit the data. The heat of vaporization calculated from the vapor pressure equation is 10,300 ± 75 cal./mole. The entropy of the liquid at 298.16° K. is 52.65 ± 0.10 cal./deg./mole and the entropy of the vapor in the ideal gas state at 1 atm. and 298.16° K. is 78.10 ± 0.35 cal./deg./mole.

Volumetric Behavior of Benzene. J. W. GLANVILLE AND B. H. SAGE. *Ind. Eng. Chem.,* **41** (1949) pp. 1272-3.

The data in the literature on the specific properties of benzene are reviewed. In experimental work the specific volume of benzene was determined at seven temperatures between 100 and 460° F., and for pressures between the vapor pressure and 10,000 pounds per square inch. The results are presented in detail in tabular form and a bibliography of nine references is included.

The Infrared Absorption Spectrum of n-Butane in the Solid State. D. W. E. AXFORD AND D. H. RANK. *J. Chem. Phys.,* **17** (1949) p. 430.

Studies of the Raman spectra of the normal hydrocarbons established the coexistence of rotational isomers in the liquid phase. Only one of these isomers persists, in general, on solidification. In the present investigation, the spectrum of solid n-butane was studied. The cell employed is described. The spectrum of liquid n-butane was also obtained. The results indicate that the transisomer is the one formed on solidification. Experiments with other paraffin hydrocarbons up to C_7 indicate simplification in the spectra on freezing.

Alkylnaphthalenes. Part IV. The Infra - red Absorption Spectra of Some Mono-alkylnaphthalenes and the Dimethylnaphthalenes. E. E. VAGO, E. M. TANNER, AND K. C. BRYANT. *Jour. Inst. of Petroleum,* **35** (1949) pp. 293-301.

In the course of an investigation into the composition of petroleum fractions boiling in the gas-oil range it became necessary to determine the concentrations of naphthalene and its homologues in distillation fractions. Napthalene and α- and β-methylnaphthalenes can be readily distinguished and estimated by ultra-violet absorption spectroscopy. However, with increase of boiling point the homologues become much less readily identified. Ultra-violet absorption curves of dimethylnaphthalenes are very similar. The investigation reported was undertaken to determine whether infrared-absorption spectroscopy would provide a more suitable means for analyzing mixtures of higher-boiling alkylnaphthalenes. The infrared absorption spectra of twelve α- and β-monoalkylnaphthalenes (methyl-, ethyl-, n-propyl-, n-butyl-, n-amyl-, and n-hexyl-) and of the ten isomeric dimethylnaphthalenes were measured in the region 700 to 1800 cm^{-1}. Characteristics of the spectra and possibilities of identification in mixtures are discussed.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

N-(p-Aminophenyl)-N-phenyl methylamine
N-(p-Aminophenyl)diphenylamine
1,1-Diacetylethylene
N-Ethyl-N-tert.-butylaniline
2-Hydroxybenzothiazole
Hendecanedioic acid
Isatoic anhydride
trans-Hexahydropthalic acid
Perfluoroethylcyclohexane
Perfluoroheptane
Phosphonium bromide
Colophene
3-tert.-Butyl-4-methoxyphenol
Dodecyl dimethyl benzyl phosphonium chloride
2,2-Difluoroheptane
1,4-Dimercaptobenzene
2-tert.-Butyl-4-methoxyphenol
2-Nitrosophenol
2,5-Dimethyl-2,4-hexadiene
Cyclooctanone

Liquid-Vapor Equilibrium of Ethanol-Toluene Solutions. CARL B. KRETSCHMER AND RICHARD WIEBE. *Jour. Am. Chem. Soc.,* **71** (1949) pp. 1793-7.

The general purpose of the program of which this investigation is a part is to study the behavior of alcohol in solutions in representative members of each of the principal classes of hydrocarbons present in gasoline. The vapor pressure of ethanol was determined at temperatures of 25° C. to the boiling point. Densities at 25° C. and vapor compositions and pressures at 35° and 55° have been measured for solutions of ethanol in toluene. Results were found to be consistent with Gibbs-Duhem relation. The excess free energy and entropy and the heat of mixing were calculated from the data. The excess entropy has negative values as for other systems containing alcohols. An empirical equation was developed that represents the liquid-vapor equilibrium of alcohol-hydrocarbon systems quite accurately. Constants in this equation are presented for ethanol-toluene solutions, and also for several systems previously investigated.

A Modified Vapour-Liquid Equilibrium Still. R. T. FOWLER. *Jour. Soc. Chem. Ind.,* **68** (1949) pp. 119-21.

The literature of vapour-liquid equilibrium stills is briefly reviewed. The author believes that one of the more accurate equilibrium stills is the one proposed by Gillespie, which is a combination of the Cottrell device with an equilibrium chamber and a vapour trap as suggested by Sameshima. A modification of this apparatus is described. It is believed that the

difficulty caused by possible rectification in the Cottrell tube and change in composition due to hydrostatic head should be negligible. A bibliography of 10 references is included.

Chemical Compositions and Reactions

Hydrogen Exchange Reactions of Paraffins in the Presence of Aluminum Chloride-Alumina Catalyst. C. D. Wagner, O. Beech, J. W. Otvos, and D. P. Stevenson. *J. Chem. Phys.*, **17** (1949) pp. 419-20.

The authors studied the reactions of seven monodeutero C_4, C_5 and C_6 paraffins in the presence of an isomerization catalyst, comprising alumina impregnated with "anhydrous" aluminum chloride. There was no exchange of hydrogen between any of the paraffins and the catalyst. However, there was intermolecular hydrogen exchange between the hydrocarbons. Intermolecular exchange of the primary hydrogen of isobutane is slow.

Hydrogen Exchange Reactions of the Butanes in Sulfuric Acid. O. Beech, J. W. Otvos, D. P. Stevenson, and C. D. Wagner. *J. Chem. Phys.*, **17** (1949) pp. 418-19.

The authors studied the reactions of four monodeutero-butanes in the presence of a typical alkylation catalyst at 25° C. Butanes were circulated through a column of sulfuric acid. It was found that neither the primary nor secondary hydrogens of n-butane react in the presence of 96.2 percent sulfuric acid in three hours. Isobutane exchanges primary hydrogens with sulfuric acid. The tertiary hydrogen of isobutane did not readily exchange. However, isobutane molecules do undergo direct intermolecular exchange of tertiary hydrogens. The presence of isobutylene has the effect of eliminating the short induction period. The rate determining factor in the reaction is either the concentration or the rate of formation of a complex compound between isobutane and sulphuric acid.

Penta-1:4-Diene. B. B. Elsner and E. R. Wallsgrove. *Jour. Inst. of Petroleum*, **35** (1949) pp. 259-63.

The authors describe and review the various methods that have been used for the synthesis of penta-1:4-diene. The method used by the authors themselves is a modification of that used by Kistiakowsky and associates. It is described in some detail and resulted in a yield of 89 percent of the diene. A bibliography of 18 references is included.

Reaction of Methane with Copper Oxide in a Fluidized Bed. W. K. Lewis, E. R. Gilliland, and William A. Reed. *Ind. Eng. Chem.*, **41** (1949) pp. 1227-37.

The reaction of methane with copper oxide was studied in a fluidized solid bed. The indications are that copper oxide readily oxidizes methane to carbon monoxide and hydrogen with high selectivity at a temperature of about 1700° F. The data were correlated on the assumption that the limiting factor is the reaction of carbon dioxide and water vapor with methane. A laboratory unit with a 4-foot bed at 1640° F. and 1 atmosphere pressure, 94 percent methane decomposition was obtained with a selectivity of 92 percent. Higher conversions could be obtained at higher temperature or at a greater depth of bed. Chemically the methane-copper oxide reaction can be regarded as proceeding in two steps. The first results in the rapid reduction to copper and the simultaneous complete oxidation of part of the methane. The second step is rate-controlling and consists of reforming of the remaining methane with carbon dioxide and water produced by the first step to form carbon monoxide and hydrogen.

Reaction of Sulphur, Hydrogen Sulphide, and Mercaptans with Unsaturated Hydrocarbons. W. H. Hoffert and K. Wendtner. *Jour. Inst. of Petroleum*, **35** (1949) pp. 171-192.

The thickening and sludging of absorption oils is basically an oxidation process, though the deterioration of these oils is accelerated when hydrogen sulphide is present. Also, an accumulation of sulphur in the oxidation or condensation products responsible for the thickening and sludging, indicates that hydrogen sulphide plays a part in the reactions. In treating olefinic systems it is desirable to remove the hydrogen sulphide immediately before oxidation can occur to elementary sulphur or other sulphur compounds that are not susceptible to removal by the usual refining methods. The chemistry of the reactions of sulphur and hydrogen sulphide with the olefins is reviewed. Mercaptans add to some olefins in the presence of acetic acid and concentrated sulphuric acid at normal temperatures. In general, the primary reaction of sulphur with the olefins is the formation of polysulphides which break up at higher temperatures to give alkyl mercaptans, dialkyl sulphides and hydrogen sulphides, which therefore are secondary and not primary products of the reaction as is generally assumed. Basic substances, such as amines, catalyse the formation of the polysulphides and thus act as sulphur carriers. Hydrogen sulphide does not react with unsaturated hydrocarbons as readily as sulphur. Mercaptans react more readily than hydrogen sulphide. A bibliography of 113 references is appended.

Manufacture: Processes and Plant

Efficiencies in Gas Absorption, Extraction, and Washing. F. M. Tiller. *Chem. Eng. Progress*, **45** (1949) pp. 391-401.

Efficiency of separation as affected by operating variables is discussed for plate and packed absorbers, cocurrent and countercurrent multiple contact extraction, and countercurrent washing. The over-all efficiency is defined as the ratio of the solute removed to the solute present. Concepts of maximum over-all efficiency and relative efficiency, which is the ratio of the actual to maximum over-all efficiency, are suggested. Graphs of efficiencies are given, indicating the normal range of operating variable which are required for high efficiencies. Solvent efficiency is defined and related to the variables involved. The relative efficiency defined in this article is equivalent to the Kremser efficiency of the well-known absorption-factor graph for values of $L/HG \geq 1$. However, it is shown for values of $L/HG < 1$ that equilibrium between outgoing gas and incoming liquid cannot be obtained, and the definition of efficiency needs modification. A bibliography of 10 references is included.

Performance of Stainless Steel McMahon Packing. A. W. Fisher, Jr. and R. J. Bowen. *Chem. Eng. Progress*, **45** (1949) pp. 359-69.

McMahon packing was made during the war from ¼ inch squares of 100-mesh brass wire cloth stamped in a final shape. The packing of two larger sizes, fabricated from ⅜-inch and ½-inch squares of 80- and 60-mesh stainless steel wire gauze were studied during fractionation tests made with an adiabatic 4-inch diameter column, 10 feet high, using benzene-ethylene dichloride mixtures and conditions of total liquid reflux. Fractionation efficiency (H.E.T.P.), pressure drop per unit height of packing and liquid holdup per unit volume of packing, are given as functions of the vapor rate. Performance of these packings is compared with ¼-inch brass and Monel McMahon saddles and with stainless steel triangular pyramidal Stedman packings. Economic comparisons are also given. McMahon packings for liquid rates as high as 2500 pounds per hour, square feet at total reflux, are shown to possess moderately good fractionation efficiencies (H.E.T.P.'s varying from 2.1 to 4.6 inches), very low liquid holdup and low resistance to vapor passage.

Mass Transfer in Systems of Gas and Fluidized Solids. William Resnick and Robert R. White. *Chem. Eng. Progress*, **45** (1949) pp. 377-90.

Few quantitative data are available on the rate at which chemical reactions proceed when catalyzed by fluidized solids, and no data are available on the rate at which mass is transferred in the fluid phase of such systems. The rates at which naphthalene is vaporized into air, hydrogen, and carbon dioxide from "fixed" and "fluidized" beds were measured. Beds comprised closely sized fractions of granular naphthalene particles ranging in size from 14 to 65 mesh. Experimental work was conducted at a temperature of 77° F. and approximately 1 atmospheric pressure, and at gas mass velocities ranging from 10 to 1200 pounds per square foot per hour. Experimental results were correlated by relating dimensionless groups that are given. A bibliography of 13 references is included.

Characteristics of Fluid-Solid Systems. G. L. Matheson, W. A. Herbst, and P. H. Holt. *2nd. Ind. Eng. Chem.*, **41** (1949) pp. 737-43.

As gas is passed through a bed of solids a time is reached when a relatively dilute suspension of solids in gas is formed above the liquid-like dense phase. As the gas velocity increases, the relative concentration of solids in the two phases becomes more nearly alike until a velocity is reached at which total entrainment of solids is encountered and a single dilute suspension exists. The present paper is limited to a study of some of the properties of the dense phase of the two-phase system. Effects of particle size and particle density on the maximum bed density and Stormer viscosity of the dense phase of fluid-solid systems was investigated. Correlations were developed quantitatively relating the increase in the maximum bed density of irregular particles with increasing particle size or particle

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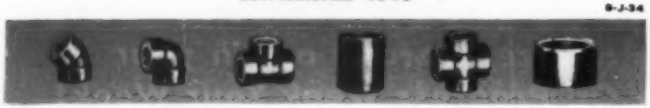

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density. The Stormer viscosity of the bed is shown to be related to the flow behavior of such systems. Viscosity of a fluidized narrow cut solid increases with increasing particle size and density. Fines have a marked influence on the viscosity of solids of wide particle size range, particularly when in concentrations up to 30 percent. The data are presented in some detail in tabular and graphical form, and a bibliography of five references is given.

Attrition Characteristics of Fluid Cracking Catalysts. W. L. Forsythe, Jr. and W. R. Hertwig. *Ind. Eng. Chem.*, **41** (1949) pp. 1200-6.

The breakdown of catalyst particles in a fluid-catalytic cracking unit is an important factor in operating costs, as it directly affects the losses of catalyst from a unit. A simplified accelerated-attrition test was developed that provides useful data evaluating catalyst resistance to attrition. The catalyst is subjected to the action of a high-velocity air jet, and screen analyses and Roller analyses made to determine the extent of particle breakdown. A comparison of natural silica-alumina, and silica-magnesia catalysts shows that all are within the same range of attrition resistance. Fresh microspheroidal catalysts show better resistance than ground catalysts except where there are excessive proportions of agglomerates. The effect of heat pretreatment at 1100° F. varies with different catalysts. Silica-magnesia catalyst showed the greatest increase in attrition resistance among the ground catalysts, while microspheroidal silica-alumina samples showed little change. Use of catalysts in operation improves attrition resistance, even during a short period. A comparison of commercial and pilot plant data indicates that the greater part of this increase in attrition resistance results from mechanical action on the particles.

Temperature Gradients and Eddy Diffusivities in Turbulent Fluid Flow. Robert J. McCarter, Leroy F. Stutzman, and Howard A. Koch, Jr. *Ind. Eng. Chem.*, **41** (1949) pp. 1290-05.

Eddy diffusivity, or the tendency of a fluid in turbulent flow to disperse material, energy, momentum, or other intensive property, is a fundamental factor in several unit operations such as heat transfer, mixing, extraction, and absorption. The object of the investigation was to examine possible methods for measuring eddy diffusivities, to determine these diffusivities under measured flow conditions, and to attempt to evaluate the factors that influence eddy diffusivity. The theory of tubulent flow is briefly presented. Elementary equations for the process of diffusion are derived and applied in the correlation of the data. Equipment and experimental procedure are described for two methods of determining the dimensional value of eddy diffusivity in turbulent gas flow by studies of the thermal energy transfer. Experiments were made in a vertical 8-inch diameter steel duct with flow velocities ranging from 2 to 7 feet per second. Preliminary results obtained indicate ranges of diffusivity for certain conditions of turbulence from which qualitative deductions can be made regarding the factors, influencing diffusion and mixing. The

method offers a possible simple and useful tool in the investigation of turbulent flow and transfer problems generally.

Catalyst Loss Recorder for Catalytic Cracking Units. J. H. RAMSER AND J. W. HICKEY. *Ind. Eng. Chem.*, **41** (1949) pp. 1244-47.

The flue gas of catalytic cracking units of the fluid type contains finely divided catalyst that escapes with the flue gas into the atmosphere and is lost. Loss may vary from a fraction of a ton to several tons per day depending on operating conditions. An instrument that continuously indicates and records the catalyst carried away with the gas has been developed. It comprises an optical device for measuring the concentration of the catalyst and a flowmeter for measuring gas velocity. The optical device and flowmeter are coupled by a mechanism that automatically multiplies concentration into rate of flow, thus giving an instantaneous loss of catalyst per unit time. The accumulated loss of catalyst is obtained by automatic integration.

Evaluation of Fluid Catalyst. Development of Laboratory Scale Units. ROLAND A. BECK. *Ind. Eng. Chem.*, **41** (1949) pp. 1242-3.

Two types of equipment were developed for the evaluation of fluidized catalyst in the laboratory. A mechanically stirred unit with helically finned rotor makes it possible to simulate fluidization independently of the gas velocity below one foot per second. A steel stirred reactor is used in research where great flexibility in regard to reactant flow rates is desired. A baffled non-stirred unit is less subject to mechanical difficulties than the stirred type. The equipment used is illustrated.

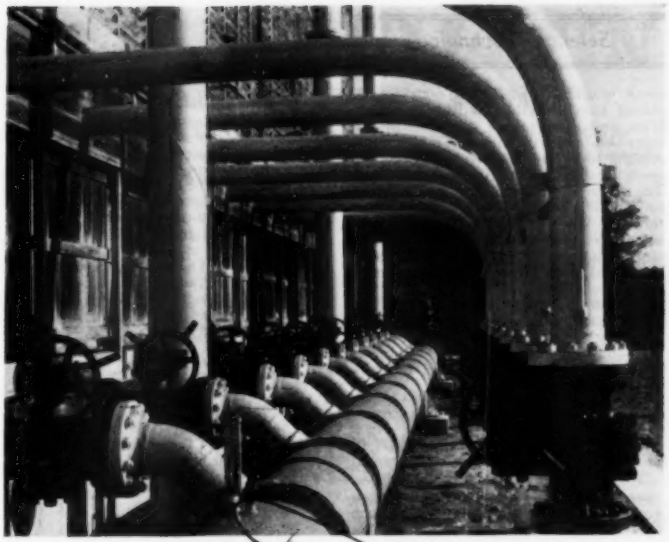
Products: Properties, Utilization and Analysis

The Influence of Tetra-Ethyl Lead on Engine Design and Performance. F. R. BANKS, C. B., O. B. E. *Jour. Inst. of Petroleum*, **35** (1949) pp. 264-92.

The author gives an historical account of the development of tetra-ethyl lead as an anti-knock agent and discusses the technical problems that have been associated with the use of leaded fuel in the automobile and the aviation engine. Tetra-ethyl lead is now accepted as an essential for use in the refinery, to help in reducing refining costs; because it is cheaper to improve anti-knock value by adding lead than by further processing of the gasoline.

Colour Measurement. E. B. EVANS, C. F. MCCUE, AND W. A. WOODROW. *Jour. Inst. of Petroleum*, **35** (1949) pp. 221-44.

The authors review the fundamental principles of colour vision and colour measurement. Instruments for measuring or comparing colour can be divided into four classes: 1) comparative instruments of limited range, 2) trichromatic colorimeters, 3) spectrophotometers, and 4) photo-electric instruments. Colorimeters used in the petroleum industry are considered under these headings and this section concludes with a description of



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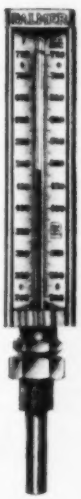

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some work that has been done by the colour panels of the Institute of Petroleum and attempts to correlate the results obtained with different instruments. Among the instruments briefly considered are the Saybolt Chromometer, the Tag-Robinson colorimeter, the Lovibond tintometer, the ASTM-Union colorimeter, the White Oil Manufacturers Association colorimeter, and the Wilson chromometer. Equivalence of colours as measured by different instruments is briefly considered and discussed. A tabular summary of results in the comparison of instruments is given. An appendix to the article presents colour terminology including general terms, photometric terms, subjective colour terms, and colorimetric terms.

Sunbury Lubricating Oil Test Engine. J. R. Crowther, T. E. Pitkethly, and R. Stansfield. *Jour. Inst. of Petroleum*, **35** (1949) pp. 245-58.

Tests of lubricating oils have been made in many laboratories on many engines over the past twenty years. Accumulated experience has made it evident that the majority of commercial designs were rarely made with sufficient precision to enable reproducible results to be obtained either from duplicate engines or from any one engine over a long period of time. Test engines should be of heavy construction so that wear of parts not connected with the test is reduced to a minimum, and the design should be such that servicing, cleaning, and renewal of parts is easy. The engine described in the article has been run up to 4000 rpm. and can be modified for supercharge at 2400 rpm. if necessary. Either dry or wet-sump lubrication can be used, and all auxiliaries are external to the engine. Engine details are described. The cylinder-liner thickness can be changed as required to control the cylinder-wall temperature. Provision has been made for thermocouples in the head of the piston and behind the top-ring groove. Oil temperature can be raised by means of an electric heater in the crankcase or cooled by passing it through a heat exchanger in the oil-pump circuit.

High Efficiency Laboratory Fractionation. II. Glass Laboratory Stills. O. G. Dixon. *Jour Soc. Chem. Ind.*, **68** (1949) pp. 119-21.

The author describes two glass fractionating columns for precise laboratory work. Both are capable of fractionating material of boiling point up to 300° C. at atmospheric or reduced pressure. The flask and column in each case are surrounded by oil jackets that prevent heat loss from the system. The jackets are electrically heated. Ring packing made of gauze, described in a previous paper, is used together with a device that enables the packing to be flooded are considered to be the features of the high efficiency of the fractionating columns. The importance of proper preflooding is emphasized. The separation of a solution containing six components, cyclohexane, cyclohexene, 4-trimethyl pentane, toluene, p-xylene and o-xylene is shown graphically and operating conditions for several typical cases are given in tabular form.

Spectrophotometric Determination of Hydrogen Sulfide. James K. Fogo and Milton Popowsky. *Analytical Chem.*, **21** (1949) pp. 732-4.

The method for the determination of hydrogen sulfide described by the authors is a refinement of the methylene blue method. Hydrogen sulfide is absorbed from gases and precipitated as zinc sulfide. The precipitate is then redissolved and allowed to react with p-aminodimethylaniline in the presence of ferric chloride. The optical density of the resulting methylene blue solution is measured at 670-millimicron wave length and the corresponding quantity of sulfide is read from a previously prepared calibration curve. The method is sensitive to about 3 micrograms and the range up to about 500 micrograms. The procedure is convenient for occasional use as well as for regular analysis.

Simplified Wire-Screen Packing for Fractionating Columns. H. J. John and C. E. Rehberg. *Ind. Eng. Chem.*, **41** (1949) pp. 1056-8.

The authors describe a wire-screen packing that is inexpensively made and highly efficient in use. No welding, grinding, precise fitting, or preassembly of parts is necessary. Ordinary glass or metal tubing is sufficiently uniform in bore for use with the packing. Fractionating efficiency, liquid holdup, and pressure drop are given for columns of 0.625, 1.0 and 2.0 inches in inside diameter. The operating characteristics of columns so packed compare favorably with those of other types of screen-packed columns, which require more skill, precision, and expense in fabrication. The test mixture used was n-heptane and methylcyclopentane. Analyses were made by measuring refractive index. A bibliography of 6 references is included.

Elemental Analysis by Lamp Combustion. G. E. C. Wear and E. R. Quiram. *Analytical Chem.*, **21** (1949) pp. 721-5.

Several modified burners that are superior to the ASTM burner for lamp combustion are described. Burners are for both volatile and nonvolatile liquids. Application of the burners to the following problems is discussed: determination of sulfur in aromatics without recourse to blending; determination of chlorine and bromine in gasoline, in which essentially complete combustion is obtained as contrasted to results 10 to 30 percent low when using the standard burner; determination of carbon and hydrogen in petroleum hydrocarbons. Although satisfactory results for hydrogen alone can be obtained with the ASTM burner, it is known to yield low results in the determination of carbon. The modified burners are illustrated by drawings and the results obtained by their use are presented in some detail in tabular form. A bibliography of eight references is included.

Detergency of Carbon Black in Hydrocarbon Solution. Part I. A. R. W. Baddeley, A. H. Nissan, and F. H. Garner. *Jour. Inst. of Petroleum*, **35** (1949) pp. 141-170.

Ability to retain carbon in suspensions of lubricating oil is commonly described as detergency, although the problem is more broadly one of both cleansing and dispersion. Suspensions of carbon black in toluene solutions of calcium naphthenate were studied to determine the degree of dispersion and the adsorption of calcium naphthenate on the carbon black. Dispersion was determined by measuring the rate of settling of the suspensions over a time of 48 hours. It was found that with increasing concentrations of calcium naphthenate a more uniform rate of settling was obtained, showing that better dispersion of carbon black had been obtained. Adsorption of calcium naphthenate on the black was determined by measuring the concentration of naphthenate in the clear solution from which the black had settled. The degree of dispersion and the adsorption of calcium naphthenate approached a maximum at 0.188 percent calcium-naphthenate concentration in toluene. In this single series of experiments the minimum concentration of calcium naphthenate to give the maximum degree of dispersion can be determined from the adsorption isotherm for calcium naphthenate on carbon black on a series of concentrations.

Bearing Corrosion Test for Lubricating Oils. E. C. Hughes, I. D. Bartleson, and M. L. Sunday. *Analytical Chem.*, **21** (1949) pp. 737-43.

The use of additives of the "detergent" type in motor oils results in increase in the bearing corrosion problem and it therefore became necessary to develop a laboratory test to predict the corrosive properties of these additives. The object of the work reported was to develop a laboratory corrosion test that could be correlated with the standard Chevrolet laboratory engine test. Much of the information gained during the development of the Sohio oxidation test was applied to the proposed test procedure. The thrust bearing apparatus adaptable to the Sohio oxidation test is described. The operating conditions and catalyst components were determined so that the test at 10 hours correlates for copper-lead corrosion with the 36-hour, L-4 Chevrolet (ASTM) test for varied groups of inhibitors and oils. At the same time correlative information is obtained on the oxidation characteristics of the lubricating oils. The test is shown to correlate for 76 oil-inhibitor combinations comprising four inhibitor types and two commercial oils. It is believed that the test will be useful both in the field of additive development as an elimination tool to indicate inhibitor-oil combinations that merit further study in the engine, and as a quality control procedure for plant batches of inhibited motor oils. Data are presented in considerable detail in graphical form, and a bibliography of 14 references is included.

Bramstedt Elected

W. F. Bramstedt has been elected executive vice president and a director of the Caltex-Bahrein group of companies. He was formerly a vice president of California Texas Oil Company before becoming president of Mid-East Crude Sales Company Limited in September, 1948. He received his degree in mechanical engineering at the University of California. For the past 22 years he has been connected with the refining, engineering, transportation and sales divisions of the oil industry.

Buys Caminol Refinery

Rothschild Oil Company, a major supplier of self-service stations, has purchased the Caminol Oil Company 5000-barrels-per-day refinery at Santa Fe Springs, Calif.

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBING EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" BRASS *Headquarters for BRASS, BRONZE and COPPER*

Are Condenser Tubes Being Injured in Storage?

Careful Handling and Good Storage Recommended to Prevent Deterioration

What happens to condenser tubes after they leave the mill? Do they receive the consideration they deserve as essential components of surface condensers and various types of heat exchangers?

Condenser Tubes Are Carefully Made

It should be emphasized that the mill considers condenser tubes as a highly specialized product. They are carefully made from special corrosion resisting alloys. Close attention is given to meet the exacting specifications as to composition, gauge, grain size, surface and straightness. Not only does each tube receive a 100% inspection, both inside and outside, but is also subjected to a 1000 pound hydrostatic pressure test to make sure that an imperfect one is not included in a shipment. For protection in handling and in transit, condenser tubes are carefully packed in wooden cases and are expected to arrive at their destination in perfect condition.

Dangers From Improper Handling and Storage

Fortunately, most operators treat condenser tubes as carefully as they do other essential supplies or equipment. However, since power plants, petroleum refineries, and chemical plants generally carry stocks of spare tubes for replacement or for retubing heat exchangers, there is danger of deterioration through improper handling and unsatisfactory storage conditions.

Improper handling may result in dents, digs, kinks, or a permanent set which predispose the tubing to premature failure.

Storage in damp warehouses, subject to a wide range of temperatures, is undesirable. Setting cases of tubing on wet floors or wet ground should be avoided because they absorb and retain moisture. Green copper salts form on tubes in contact with the wet walls of wooden cases. Condensation of moisture leads to surface corrosion with the formation of brown, black, green and other colored film or corrosion products.

Outdoor storage of tubes is generally very undesirable. It may lead to accumulation of dust, cinders and soot, which, together with condensation and moisture produce serious corrosion on the outside surface of the tubing. Covering with a tarpaulin, unless arranged to permit free circulation of air, may retain dampness. The combined action of high humidity and certain contaminants in the atmosphere may produce season cracking, especially if the storage period is extended.

Recommendations

Treat condenser tubes with care. They can be injured with resulting lower service life.

1. Keep tubes in cases, flat until ready for use—but don't stack too high to avoid crushing of bottom cases.

2. Select a dry, protected storage location not subject to extremes of humidity and temperature.

3. Avoid outdoor storage especially where there is dirt, smoke, soot and corrosive fumes.

4. If cases become watersoaked, both the cases and tubes should be promptly dried out.

5. When ready to use, remove tubes from cases carefully.

6. If stored in racks, tubes should be properly supported.

Corrosion Problems

Corrosion is a constant menace to the life of condenser and heat exchanger tubing. Much has been learned of the characteristics of various alloys. There is still much to learn on this subject. Much help is coming in from operators all over the country who share their experience on the behavior of various alloys under actual operating conditions. Bridgeport's Corrosion Laboratory appreciates this fine cooperation and is anxious to be of service to condenser and heat exchanger users.

BRIDGEPORT BRASS

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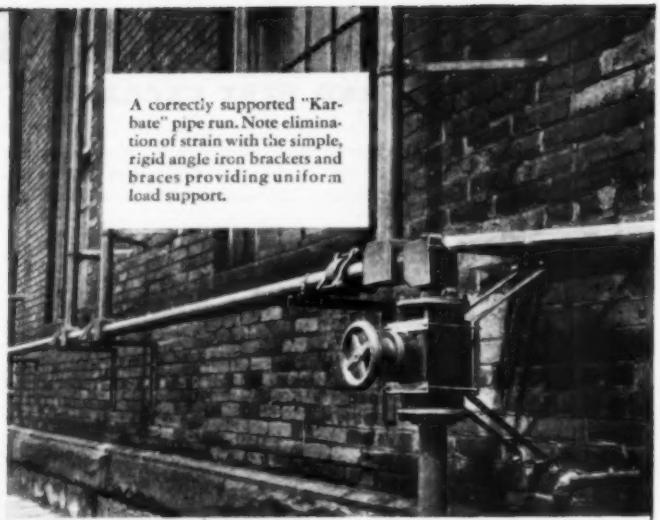
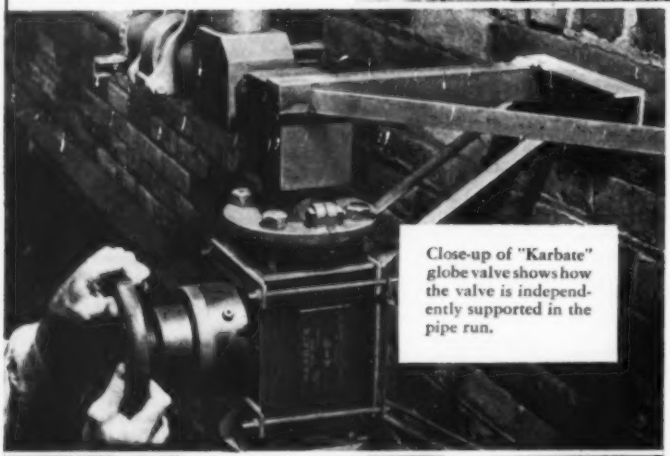
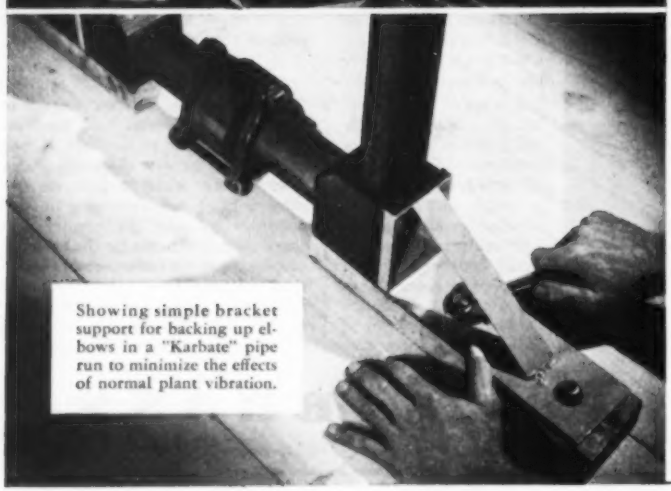
How to support a "Karbate" pipe line.



A correctly supported "Karbate" pipe run. Note elimination of strain with the simple, rigid angle iron brackets and braces providing uniform load support.



Close-up of "Karbate" globe valve shows how the valve is independently supported in the pipe run.



Showing simple bracket support for backing up elbows in a "Karbate" pipe run to minimize the effects of normal plant vibration.

KEEP "KARBATE" PIPE ALWAYS IN STOCK

- Resists the action of acids, alkalies and other chemicals
- Light weight with adequate strength
- Resistant to mechanical shock
- Immune to thermal shock
- Easy to machine and install
- Full range of sizes and fittings

Write for Installation Manual M-8801 A. Address Dept. PR.

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The term "Karbate" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

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Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Foreign Department—New York, U.S.A.

These products sold in Canada by Canadian National Carbon Co., Ltd., Toronto 4, Canada

Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, May 17, 24, 31 and June 7, 1949)

REFINING

U.S.P. 2,470,207. Isobutylene Extraction. B. S. Garrett to Standard Oil Development Company.

In the recovery of isobutylene from a C4 hydrocarbon mixture by extraction of the mixture with H_2SO_4, vaporizing a major portion of the hydrocarbons from the extract under pressure, and recycling of the recovered H_2SO_4, a mineral oil boiling in the range of 400-900° F. is added to the circulated H_2SO_4 in small amounts to eliminate foaming during the regeneration.

U.S.P. 2,470,339. Continuous Adsorption Process. W. H. Claussen and W. H. Shiffler to California Research Corporation.

Petroleum stocks or mixtures containing paraffinic and aromatic hydrocarbons are continuously separated by contact with a solid adsorbent in the liquid phase. The mixture to be separated is fed at an intermediate point to the particle-form adsorbent moving downwardly as a columnar mass. A non-adsorbed fraction is withdrawn from the upper portion of the adsorption zone. The selectively adsorbed fraction is treated in a specified manner.

U.S.P. 2,470,438. Absorption Process. R. M. Jackson and P. J. Harrington to Standard Oil Development Company.

For refining petroleum distillates, gaseous fractions thereof are intimately dispersed into the liquid fractions, and vice versa. Details are claimed of the process and of the apparatus employed.

U.S.P. 2,470,634. Apparatus for Deleading Gasoline. J. D. Morgan, S. R. Merley and W. E. Smith to Cities Service Oil Company.

Details of a unit are claimed for removing lead antiknock compounds from gasoline. A part of the unit is heated to a controlled temperature to vaporize the gasoline and decompose the antiknock compounds.

U.S.P. 2,470,782. Separation of Organic Compounds. H. G. McGrath, H. F. Passino and L. C. Rubin to The M. W. Kellogg Company.

For separating oxygenated compounds from hydrocarbons contained in the reaction product of a Fischer-Tropsch synthesis process, this product is cooled to form an uncondensed gas phase, an oil phase and a water phase, each of these phases containing at least a portion of the hydrocarbons and at least a portion of the oxygenated compounds. The oil phase is extracted with a solvent for oxygenated compounds, e.g., glycol. A hydrocarbon-free extract and a lean oil raffinate are thus formed. The water phase is distilled to separate a high-boiling aqueous mixture of organic oxides, esters, aldehydes, ketones and alcohols with at least 4 C atoms and a low-boiling fraction comprising alcohols with up to 3 C atoms. The high-boiling aqueous mixture is extracted with a portion of the lean oil raffinate. An extract containing alcohols with at least 4 C atoms and a water raffinate are formed. This extract is passed to the first extraction treatment.

U.S.P. 2,470,808. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

A water-in-oil type petroleum emulsion is demulsified by treating it with a product consisting of an oxyalkylated, drastically oxidized, partially hydroxylated polyethylenic acid or its glyceride. Hydrogen peroxide is employed for the hydroxylation, an alkylene oxide with not over 4 C atoms for the oxyalkylation, and a gaseous oxygen containing medium for the oxidation. Marine oils are preferably used for preparing the demulsifier.

U.S.P. 2,470,829. Processes for Breaking Oil-in-Water Emulsions. L. T. Monson to Petrolite Corporation, Ltd.

An oil-in-water emulsion in which the petroleum oil dispersed phase is not greater than 20 percent is demulsified by treatment with an acylated derivative of a basic aminoalcohol of the formula:

$$H(OR')_nN\begin{matrix}R''\\R''\end{matrix}$$

U.S.P. 2,470,887. Method of Treating Cracked Gasoline to Remove Metals. F. A. Chenicek to Universal Oil Products Company.

Cracked gasoline is freed from a small amount of metal, such as copper left therein from a preceding copper sweetening operation, by contacting the gasoline with a solution of an o-hydroxy aromatic aldehyde (e.g., salicylaldehyde) in an excess of an alkylene polyamine or alkanol amine (e.g., ethylene diamine or ethanol amine).

U.S.P. 2,471,107. Recovery of Hydrocarbon Oil. C. E. Hemminger to Standard Oil Development Company.

Hydrocarbon oil is continuously recovered from bituminous solids by extracting the dried solids with vaporized hydrocarbons preheated to extraction temperature, these hydrocarbons being obtained by settling from the oil slurry remaining as a residue in the extraction operation. More details of the process are claimed.

U.S.P. 2,471,550. Treatment of Coke-Oven Gas. J. A. Shaw to Koppers Company, Inc.

Coke oven gas which contains olefins and acetylene is passed through a strong $AgNO_3$ solution under elevated pressure to absorb olefins and acetylene. The rich solution is distilled under reduced pressure to separate olefins while retaining the acetylene. A major portion of the olefin-free solution is recycled to the absorption zone. The remaining portion of this solution is treated with $HgNO_3$ to precipitate the acetylene compounds. The $AgNO_3$ solution is then returned to the absorption zone.

U.S.P. 2,471,602. Treatment of Hydrocarbons. P. M. Arnold to Phillips Petroleum Company.

Ethylene is recovered from a feed stock also containing hydrogen and methane by fractionation. An overhead comprising most of the hydrogen and some methane is removed. The liquid bottoms are again fractionated to remove methane overhead, which is condensed. A portion of this condensate is employed for refluxing the demethanizing operation. On further treatment a bottoms of ethylene is obtained from the demethanizing operation.

U.S.P. 2,472,217. Refining Hydrocarbon oils. E. E. Langan, N. E. Lemmon, and F. W. Schuessler to Standard Oil Company of Indiana.

Viscous petroleum oil is refined by treatment with fuming sulfuric acid. The treated oil containing at least 0.05 percent SO_2 is treated with an amount of alkali metal hydroxide in excess of that required for neutralization. The neutralized oil is air-blown in the presence of this excess neutralizing agent at a temperature of 150-200° F. to reduce the water content to less than 0.1 percent.

U.S.P. 2,472,250. Process for Separating Hydrocarbons by Adsorption. A. E. Hirschler to Sun Oil Company.

Two hydrocarbons, A and B, with the same degree of saturation are separated by selective adsorption utilizing both

activated carbon and silica gel. While the mixture of A and B has the same adsorbability on one of these adsorbents when A and B are in a certain definite proportion, A is more adsorbable than B on the other of the adsorbents at all proportions of A and B below and up to a proportion exceeding the certain definite proportion. The mixture is first treated in a particular manner with one of the two adsorbents. The adsorbate of this treatment is separated from the filtrate, which contains B in a more nearly pure form, is then treated in liquid phase with the adsorbent not employed in the first step to adsorb B and obtain a filtrate containing A in a more nearly pure form.

U.S.P. 2,472,459. Method and Apparatus for Feeding Adsorbent Materials to Streams of Liquid Hydrocarbons. D. B. Banks to Sun Oil Company.

For removing impurities from liquid hydrocarbons, predetermined quantities of finely divided adsorbent material are added continuously to a body of the preheated hydrocarbons. The vapors formed in the treating tank which contain entrained adsorbent are removed to a heating zone and then to a separating zone. While the separated adsorbent particles are returned to the treating tank, the separated vapors are returned to the heating zone to be mixed with the vapors removed from the tank.

U.S.P. 2,472,463. The Distillation of a Mixture of Hydrocarbons. R. C. Brandon and M. C. K. Jones to Standard Oil Development Company.

Cracked gasoline containing gum forming unsaturated hydrocarbons is mixed with about one-fourth its volume of petroleum phenols and a H_2SO_4 or ar. sulfonic acid catalyst. On distillation of this mixture a gasoline of substantially greater storage stability is recovered overhead.

U.S.P. 2,472,487. Butadiene Extraction. J. B. Lovell to Standard Oil Development Company.

A liquid mixture of diolefin containing hydrocarbons is contacted with a cuprous salt solution to extract the diolefin and is then passed to a settler where separate layers of the hydrocarbon mixture and the solution are formed. A portion of this solution is withdrawn from the interface of both layers in order to remove substances with a tendency to promote foaming and emulsification.

U.S.P. 2,472,499. Solvent Extraction of Oil. C. M. Stone to The Texas Company.

In the fractional extraction of hydrocarbon oil with a water soluble organic solvent, a mixture of the extracted oil fraction and solvent is obtained. The solvent is separated from the extracted oil with steam and the thus formed mixture of solvent and water is passed to an absorption zone where it is contacted with a non-aqueous liquid absorbent for the solvent which is higher boiling than water, at a temperature above the boiling point of water. The water is thus removed as vapor. The solvent is recovered from the remaining liquid stream of absorbent.

U.S.P. 2,472,573. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

A demulsifier for breaking petroleum emulsions of the water-in-oil type include a cation-active polychloride obtained by reacting diglycol chloroformate and a hydroxylated mono-acylated amine of particular constitution.

U.S.P. 2,472,574. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

The demulsifier for breaking petroleum emulsions of the water-in-oil type according to this patent includes an oxyalkylated, drastically oxidized oiticica oil-caster oil condensate obtained in a particular manner claimed in detail.

U.S.P. 2,472,578. Method of Contacting Fluids. S. W. Ferris, E. R. Lamson, and D. M. Smith to The Atlantic Refining Company.

For contacting a liquid hydrocarbon mixture with a fluid partially immiscible therewith, e.g., a partially immiscible solvent, the hydrocarbon mixture is continuously supplied between a plurality of vertical, horizontally-spaced guides to form a thin film with two exposed surfaces extending between and wetting the guides. The hydrocarbon film is continuously flowed between the guides in intimate contact with said fluid without rupture of the film.

U.S.P. 2,472,610. Distillation of Olefin-Hydrogen Chloride Mixtures. A. C. Nixon, D. C. Lehwalder, and H. A. Cheney to Shell Development Company.

For separating HCl in high purity from its mixture with olefins by fractionation at elevated pressure, nickel is employed for all surfaces of the fractionating zone to avoid any interaction of HCl and olefins during the fractionation.

CATALYST PREPARATION, ACTIVATION, and REGENERATION

U.S.P. 2,470,142. Production of Catalysts of the Silica-Alumina Type. C. C. Chapman and H. V. Hendrix to Phillips Petroleum Company.

Details are claimed of a process for the preparation of a silica-alumina catalyst of high and relatively uniform activity. This is achieved by controlling certain of the process steps much more carefully and closely than others.

U.S.P. 2,470,175. Liquid Hydrogen Fluoride Composition. C. B. Linn to Universal Oil Products Company.

Liquid HF having dissolved therein an acid of phosphorus in an amount of 1-50 percent by weight is useful as a polymerization catalyst for olefins, such as propylenes and butylenes, to form gasoline hydrocarbons.

U.S.P. 2,470,410. Preparation of Silica Magnesia Catalysts. K. J. Nelson to Standard Oil Development Company.

A water suspension of silica hydrogel and magnesia is mulled for 15 seconds to 20 minutes. The slurry formed is aged at a temperature of 125-200° F. for about 2-12 hours and then dried at a temperature of 225-600° F. The catalyst obtained is useful in the cracking or other treatment of hydrocarbons.

U.S.P. 2,470,411. Process of Preparing a Silica-Magnesia Gel Catalyst. E. S. Corner to Standard Oil Development Company.

A silica hydrogel or gelatinous precipitated silica is mixed with magnesia and water. The slurry formed, which contains not less than 10 percent solids, is mulled to form a homogeneous mixture which is then aged at a temperature of 60-90° F. for 8-150 hours and thereafter dried and activated. The conversion catalyst produced has improved steam stability.

U.S.P. 2,470,486. Process of Regenerating Magnesium Silicate Adsorbents. R. J. Hawes to Tide Water Associated Oil Company.

A magnesium silicate adsorbent spent in the decolorization of mineral oil is regenerated by removing the adsorbed coloring bodies from the adsorbent and then intimately contacting it with an aqueous solution containing magnesium ions for further improving its adsorbing efficiency.

U.S.P. 2,470,688. Alkali-Alkaline Earth Hydroxide-Impregnated Carbon Catalyst and Its Preparation. A. G. Carter to American Magnesium Metals Corporation.

A catalyst, useful in the removal of CS_2 from gases, the conversion of acetylene into acetone or alcohols, the conversion of ethylene into alcohol or ether, etc., comprises a coherent mixture of amorphous carbon, at least one hydroxide of Mg, Ca, Sr, Ba or Be and at least one alkali hydroxide or carbonate.

U.S.P. 2,470,784. Gamma Iron Oxide-Alkali Metal Ferrate and Process of Preparation. M. A. Mosesman to Standard Oil Development Company.

A Fischer-Tropsch synthesis catalyst is prepared by mixing gamma iron oxide with 0.2-20 percent of alkali metal ferrate, heating the mixture at about 1000° C. for four hours in an oxidizing atmosphere and then heating it in a reducing atmosphere at 700-1600° F. for about 24 hours.

U.S.P. 2,470,785. Alpha Iron Oxide-Alkali Metal Ferrate Catalyst and Process of Preparation. M. A. Mosesman to Standard Oil Development Company.

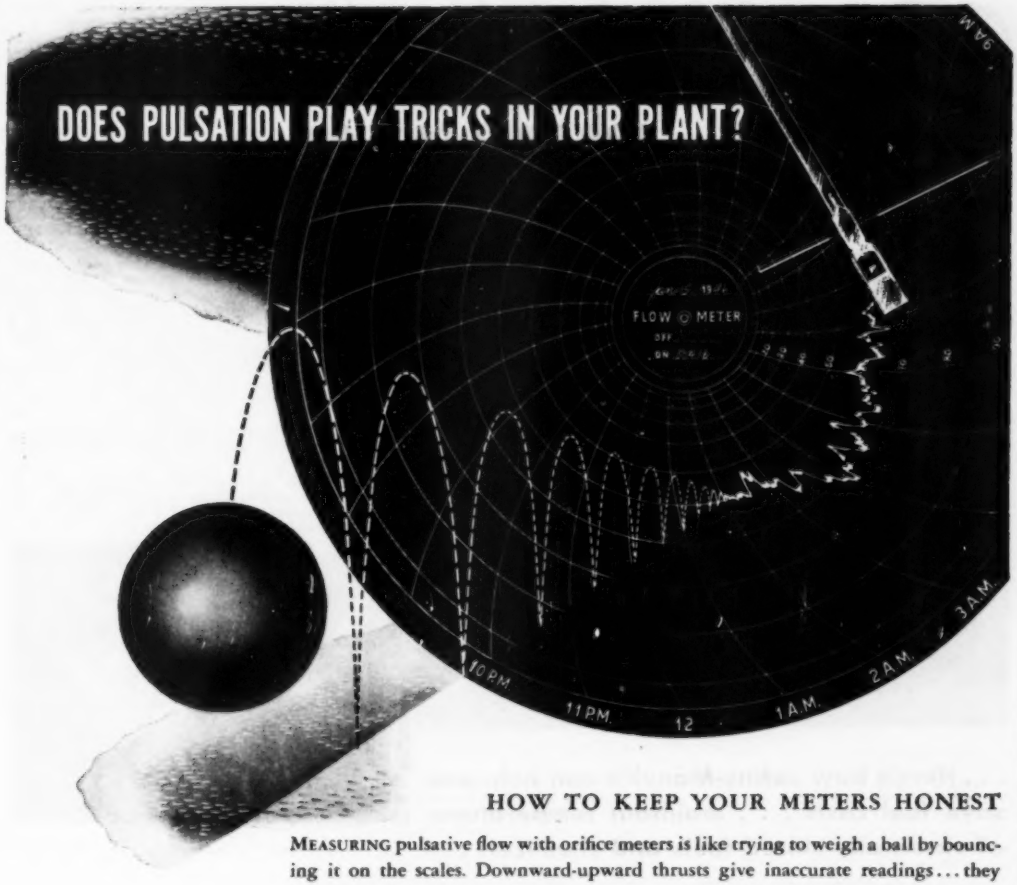
The process of this patent differs from that of U.S.P. 2,470,784 only in that alpha iron oxide is employed instead of the gamma compound.

U.S.P. 2,470,786. Ferro-Ferric Oxide-Alkali Metal Ferrate Catalyst and Its Method of Preparation. M. A. Mosesman to Standard Oil Development Company.

In the present case ferro-ferric oxide is employed instead of the gamma iron oxide used in U.S.P. 2,470,784.

U.S.P. 2,470,872. Preparation of Acid Activated Clay. R. B. Secor to Filtrol Corporation.

Activatable clay, e.g., sub-bentonite, is compressed into stable forms of in-



HOW TO KEEP YOUR METERS HONEST

MEASURING pulsative flow with orifice meters is like trying to weigh a ball by bouncing it on the scales. Downward-upward thrusts give inaccurate readings... they happen so fast the measuring instrument can't keep up with them. To keep your orifice meters honest, pulsative flow must be converted into a steady stream. The FLUOR Pulsation Dampener is the practical answer to this problem.

For example—a large Eastern Gas Company pumps gas into underground storage during the summer and withdraws it during the winter when consumer load is heaviest. As storage reservoir pressure drops, it becomes necessary to compress the gas to maintain pressure in the mains. Pulsations set up in the gas stream by the compressors threw the meters off by such substantial amounts that the Company was unable to determine how much gas was being pulled out of the reservoir. FLUOR Pulsation Dampeners installed in the suction lines between the meters and compressors eliminated this condition and made accurate measurement possible.

The FLUOR Pulsation Dampener changes pulsative flow into smooth, steady flow... with beneficial effect on frictional losses, horsepower savings and rate of flow. If vibration plays *tricks* in *your* plant, it may be due to pulsations in air, gas or vapor lines. In that case, the FLUOR Pulsation Dampener is your answer.

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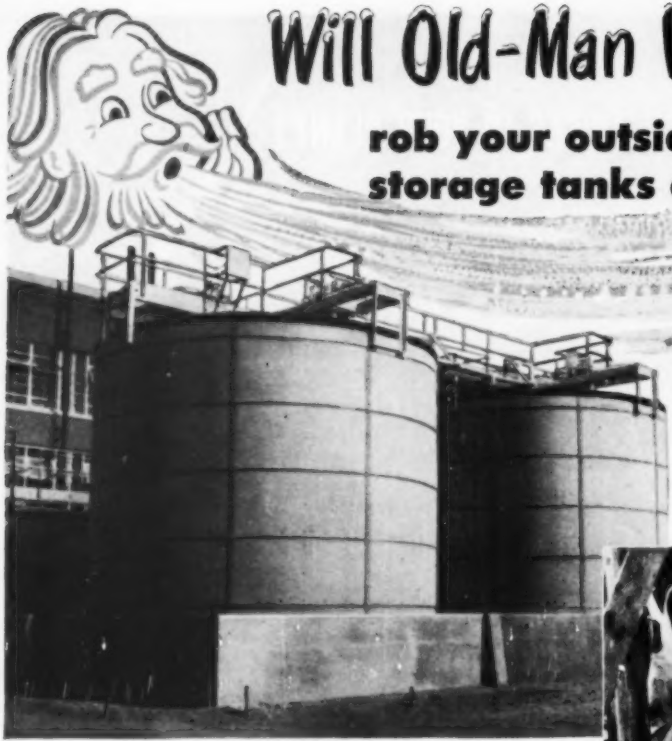
Will Old-Man Weather...

rob your outside storage tanks of costly Btu's?



Left: These neat-appearing, insulated tanks are weather-protected by the Johns-Manville specification described here.

Below: Applying J-M Asbestocite (asbestos and cement sheets that are weather- and corrosion-resistant) over standard J-M Insulations.

... Here's how Johns-Manville can help you save fuel costs . . . maintain temperatures of externally stored fuels and chemicals . . .

IF YOU HAVE OUTDOOR tanks and vessels... and are heating or cooling them it will pay you to look into the Johns-Manville Weather-Protected Insulation specification.

Weather-Protected Insulation pays even though outdoor storage tanks are operated at moderate temperatures—because wind and other weather conditions can greatly affect tank temperatures. Savings, for example, on a standard fuel storage tank operating at 130 F maintained temperature can be as much as 200 Btu/sq. ft./hr.

Basically, this Johns-Manville Weather-Protected Insulation specification consists of standard J-M insulations over which is applied Johns-Manville Asbestocite (asbestos-cement sheet) to protect the insulation from the weather. Shielded in this manner, the insulation pays dividends in fuel savings for many years.

If you wish, a Johns-Manville Insulation Engineer will be glad to survey your outdoor equipment to estimate fuel savings for you. Or, for more details send for a copy of folder IN-121A. Johns-Manville, Box 290, New York 16, New York.

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creased density and then activated by acid treatment, washed to remove soluble salts and residual acid, and dried. The product is well suited for use in fluid catalytic cracking processes.

U.S.P. 2,471,000. Alumina Gel Pellets. J. A. Messenger to Socony-Vacuum Oil Company, Inc.

A hydrosol of alumina is introduced into a body of water-immiscible liquid maintained above a body of an aqueous solution of a base capable of converting the hydrosol to a gel. Sol globules of spheroidal shape formed pass through the interface into the aqueous solution where they are transformed to spheroidal hydrogel particles. An inert water soluble organic liquid, such as an aliphatic alcohol, capable of reducing the density differential and the interfacial tension between the bodies of the two liquids is admixed to the aqueous liquid.

U.S.P. 2,471,986. Storage of Hydrofluoric Acid. P. M. Waddill to Phillips Petroleum Company.

In order to minimize the storage loss of HF added as a catalyst from a storage vessel to a process for the conversion of hydrocarbons, the HF is substantially maintained in liquid phase in said vessel under an atmosphere of inert pressuring gas. Between the acid layer and the gas a liquid layer of a heavy paraffin or the like is introduced, through which the HF is undiffusible.

U.S.P. 2,472,489. Preparation of Clay Catalysts. J. A. Pierce to Standard Oil Development Company.

Bentonite clay is digested with H_2SO_4 for activation, then washed, dried and hereafter treated with a dilute HCl wash. The clay is finally heated to 800-1200° F. A cracking catalyst is obtained.

U.S.P. 2,472,490. Process of Preparing Porous Glass Catalysts. C. J. Plank to Socony-Vacuum Oil Company, Inc.

Porous siliceous compositions, suitable as catalysts and promoting catalyst carriers in hydrocarbon conversions, are prepared from a glass melt of certain proportions of an alkali metal oxide, boric oxide, silica, and an iron, copper, or nickel oxide. The melt is heated at a temperature of 400-650° C. to effect a glass with a phase rich in silica, a phase poor in silica, and a devitrified phase. The glass is leached with a dilute solution of a mineral acid or a conc. solution of NH_4Cl to dissolve out the phase poor in silica and the devitrified phase.

U.S.P. 2,472,501. Process of Regenerating Synthesis Catalyst with Oxygen and Return of Oxidized Catalyst to the Synthesis Reactor. S. B. Sweetzer to Standard Oil Development Company.

A portion of fouled fluidized iron catalyst of a Fischer-Tropsch synthesis is withdrawn from a lower portion of the reaction zone and regenerated by an oxidizing gas. The thus oxidized catalyst is returned to the reaction zone. The rate of oxidized catalyst return is controlled at a value of less than 2 percent by weight of the total catalyst per hour.

U.S.P. 2,472,776. Method of Heat-treating Particle-form Solid Adsorbents. J. W. Payne to Socony-Vacuum Oil Company, Inc.

Particle form solid contact masses, e.g. gel-type bead catalysts, are heat-treated for drying, regeneration, or the like without substantial breakage or cracking of the solid particles in a particular manner claimed in detail. The mass is first preheated to a temperature of 300-700° F. and then further heated to a temperature above 1000° F.

CRACKING AND REFORMING

U.S.P. 2,470,193. Treatment of Hydrocarbons. W. M. Stratford to The Texas Company.

Vaporized higher boiling hydrocarbons are passed in contact at cracking temperature with a magnesium silicate catalyst produced by subjecting lime and silica to reaction with a soluble Mg salt in the presence of water at elevated temperature. Lower boiling hydrocarbons are obtained.

U.S.P. 2,470,263. Hydrocarbon Conversion Process. N. E. Peery to Shell Development Company.

Recycled oil from the catalytic cracking of higher boiling hydrocarbons to produce gasoline is subjected to mild thermal cracking conditions in the presence of 0.5-10 pounds per barrel of a suspended catalyst. The product is quenched by the addition of virgin gas oil. The mixture is subjected to vapor phase catalytic cracking in the presence of at least 100 weight parts of the cracking catalyst per part of oil. The product is fractionated to separate resulting gasoline from a recycle oil which is further treated as described above.

U.S.P. 2,470,445. Production of High Octane Number Aviation Gasoline. K. M. Purdy to Standard Oil Development Company.

Light gas oil is catalytically cracked at temperatures of 800-850° F. and at conversions of 45-55 percent by vol. Heavy gas oil is catalytically cracked at temperatures of 950-1000° F. and at conversions of 55-85 percent by vol. A C_4-230° F. cut from the product of the first cracking step is blended with a 230-325° F. cut of the second cracking step to produce a high octane aviation gasoline.

U.S.P. 2,470,680. Process for Cracking Hydrocarbon Oils. H. Beuther to Gulf Research and Development Company.

A stream of light hydrocarbon oil containing normally gaseous hydrocarbons largely paraffinic in character is subjected to drastic cracking conditions (e.g., at a temperature of 900-1300° F.). Normally gaseous hydrocarbons of more highly olefinic character are then added and the resulting mixture is further cracked under less drastic conditions, (e.g., at a temperature of 800-1200° F.). Gasoline is produced.

U.S.P. 2,471,078. Catalyst Quality by Magnetic Separation. H. J. Ogorzaly to Standard Oil Development Company.

Hydrocarbon feed gases are passed under cracking conditions through a fluid bed of non-magnetic catalyst particles. Removed hot reactant vapors are separated from entrained catalyst. At least a portion of these vapors containing only small residual amounts of active catalyst fines and undesirable particles comprising iron is passed through a segregation zone in which an electro-magnetic field is imposed to separate the iron particles.

U.S.P. 2,471,104. Production of Unsaturated Hydrocarbons and Hydrogen. E. J. Gohr to Standard Oil Development Company.

Normally gaseous hydrocarbons are converted and hydrocarbons are cracked under high-temperature conditions by intermingling the hydrocarbons with highly heated refractory powder, the amount and temperature of the powder being sufficient to supply the heat required for the reaction. Details of this method are claimed. Highly unsaturated hydrocarbons, such as acetylene, and hydrogen are produced.

U.S.P. 2,471,131. Catalytic Conversion of Hydrocarbon Oil. P. S. Viles to Standard Oil Development Company.

Hydrocarbons are contacted with a finely divided suspension of a cracking catalyst contaminated with metals promoting the formation of carbon and fixed gases at conversion temperature. The spent catalyst removed from the reaction products is regenerated by oxygen-containing gas and an inhibiting amount of NiS sufficient to suppress the formation of C and fixed gases (0.1-0.5 percent by weight of the catalyst) is introduced with the regenerated catalyst and the hydrocarbon oil into the reactor.

U.S.P. 2,471,228. Production of Hydrocarbons. E. V. Mathy to Phillips Petroleum Company.

In the cracking of hydrocarbon oils to form lower boiling unsaturated hydrocarbons, a cracking catalyst is employed which has been impregnated with a catalyst active for the hydrocarbon synthesis from CO and H_2. A mixture of these gases in less than a 4:1 vol. ratio of H_2 to CO is introduced into the catalyst zone at at least one point subsequent to the point of entry of the hydrocarbon oil to be cracked and in quantities sufficient to react independently of and concomitantly with the cracking to form unsaturated hydrocarbons heavier than methane, but insufficient to furnish hydrogen for reaction with the unsaturated products.

U.S.P. 2,472,669. Preventing Coke Formation in Preheater Tubes. E. V. Mathy to Phillips Petroleum Company.

A wide cut gas oil with a boiling range of 400-750° F. is heated to a vapor phase cracking temperature with addition of 1-10 percent by vol. of a liquid non-coking oil with an average boiling point above 1050° F. and above the temperature to which the gas oil vapors are to be heated. Deposition of coke on the heater tube walls is inhibited by the presence of said high boiling additive oil during the vaporization of the gas oil.

U.S.P. 2,472,723. Method for Removal of Metal Compounds from Oil Feed to Fluid Catalyst Cracking. N. P. Peet to Standard Oil Development Company.

Residual hydrocarbon feed stock containing contaminants which is charged

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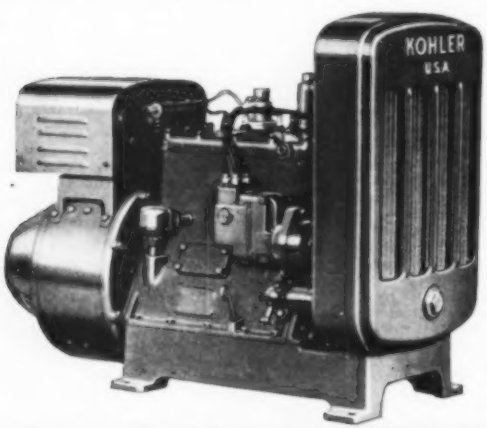

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Patents

to a fluid catalytic operation is admixed at least in part with contact clay of particular particle size to form a slurry. This slurry is introduced into the residual feed stock and catalyst is added to the mixture which is then treated under conversion conditions in a reaction zone. The reaction products are separated from the catalyst and clay which are regenerated under combustion conditions. The regenerated catalyst is separated from the spent clay and returned to the system. Contaminating metals and metal compounds in the hydrocarbons detrimental to the effect of the conversion are eliminated by the addition of the clay.

ALKYLATION

U.S.P. 2,470,712. Catalytic Dealkylation of Alkylated Compounds. C. W. Montgomery and W. A. Horne to Gulf Research & Development Company.

A high boiling alkyl aromatic hydrocarbon is dealgylated into a lower boiling homologue in contact with hydrogen and a metallic catalyst of the VIII group of the periodic system at a temperature of 250-400° C. The hydrogen is periodically purged from the mixture (e.g., with nitrogen) while continuing contact between the catalyst and the aromatics. The process increases the yield of liquid products.

U.S.P. 2,471,211. Alkylation Catalyzed by Liquid Hydrogen Fluoride. S. T. Hadden to Socony-Vacuum Oil Company, Inc.

In the alkylation of isoparaffins with olefins in the presence of HF in a fractionating column, a fresh feed of the reactants is introduced below an intermediate tray of the column. Details of this process are claimed.

U.S.P. 2,471,922. Production of Aromatic Derivatives. W. N. Axe to Phillips Petroleum Company.

An aromatic hydrocarbon, such as benzene, is reacted with a normal 1,3-diolefin, e.g. 1,3-butadiene, at a temperature of 75-150° F. under a pressure sufficient to maintain the reactants in the liquid phase. The mol ratio of the aromatic to the olefin shall be 2:1 to 10:1. The catalyst employed is a liquid complex resulting from reacting BF_3 with H_3PO_4. Alkenyl aromatic compounds, such as phenyl butene, are produced.

ISOMERIZATION

U.S.P. 2,470,144. Isomerization and Alkylation of Normal Paraffins. L. A. Clarke to The Texas Company.

A normal paraffin hydrocarbon is mixed with a minor mol proportion of an olefin and the mixture is reacted in the presence of a catalyst comprising anhydrous HF and a minor mol proportion of BF_3 under conditions below a temperature of 150° F. wherein the pressure is such as to maintain the hydrocarbons and the HF in liquid phase. Substantially saturated branched-

chain hydrocarbons are formed. Isomerization and alkylation take place simultaneously.

U.S.P. 2,471,054. Removal of Soluble Catalysts from Product Streams. E. H. Amick, Jr. to Standard Oil Development Company.

Saturated straight-chain hydrocarbons are contacted with an aluminum halide catalyst under isomerization conditions. The resulting product stream is further heated to a temperature near but not above its critical temperature under a pressure sufficient to maintain this stream in the liquid phase. A phase relatively rich in catalyst is then separated from a liquid product phase free of the catalyst. The latter phase is fractionated.

U.S.P. 2,471,647. Isomerization of Olefins in the Presence of Hydrogen Fluoride Impregnated Alumina. A. G. Oblad and J. U. Messenger to Socony-Vacuum Oil Company, Inc.

Straight chain olefins with not more than 6 C atoms are contacted at isomerization temperature, e.g. 500-950° F., with a catalyst consisting essentially of alumina impregnated with HF and containing fluorine equivalent to 0.5-10 percent of HF based on the total weight of the catalyst. Isoolefins are obtained.

POLYMERIZATION AND CONVERSION

U.S.P. 2,470,166. Polymerization of Ethylene. S. J. Hetzel and R. M. Kennedy to Sun Oil Company.

Ethylene is polymerized in the presence of a catalyst essentially consisting of silica gel, chromia, and nickel or cobalt metal. Considerably lower pressures than heretofore employed are required in the polymerization by means of this catalyst.

U.S.P. 2,470,171. Polymerization of Olefins. R. M. Kennedy and S. J. Hetzel to Sun Oil Company.

The process according to this patent is closely related to that of U.S.P. 2,470,166. A catalyst consisting by weight of 80-99.98 percent silica gel, 0.001-10 percent chromia, and 0.01-10 percent of nickel or cobalt is here employed for the polymerization of olefins with at least 3 C atoms.

U.S.P. 2,470,190. Production of Olefin Polymers. L. Schmerling to Universal Oil Products Company.

Higher boiling hydrocarbons are produced by reacting an olefinic hydrocarbon and a monohaloalkane in the presence of a metal phosphate catalyst under suitable conditions.

U.S.P. 2,470,395. Apparatus for Carrying Out Catalytic Reactions. E. J. Gohr and C. W. Tyson to Standard Oil Development Company.

Details are claimed of an apparatus for contacting gases and finely divided solids. It is useful, for example, in the cracking or dehydrogenation of hydrocarbons in the presence of a fluidized catalyst, in the regeneration of catalysts

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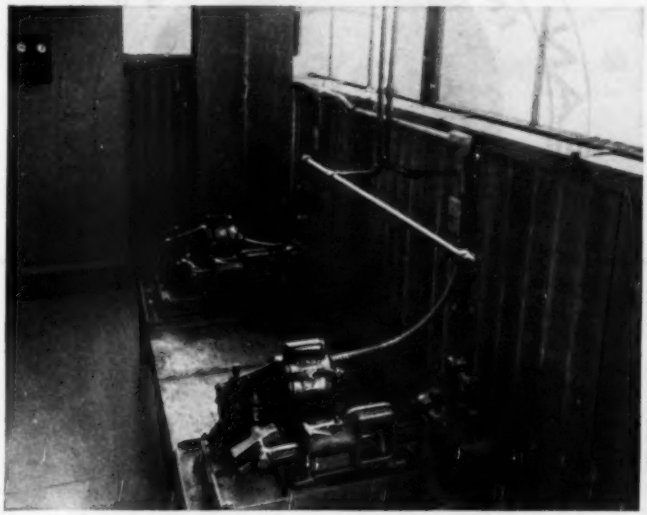

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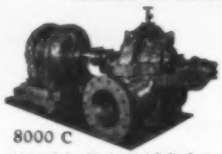
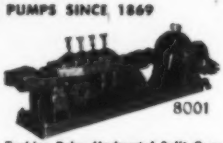


8000 C

Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

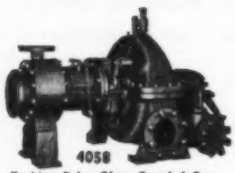


8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

3833

Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

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Patents

by air oxidation, etc. The apparatus makes possible ready heating and cooling of the reaction vessel by the withdrawal of a stream of the solid from this vessel and passing this stream through a heat exchanger before returning it to the reactor.

U.S.P. 2,470,417. Emulsion Polymerization in the Presence of Selectively Hydrogenated Tallow Soaps. B. M. Vanderbilt and J. D. Hetchler to Standard Oil Development Company and Archer-Daniels-Midland Company, respectively.

Conjugated diolefins with 4-6 C atoms are emulsion polymerized either alone or mixed with other ethylenically unsaturated compounds in the presence of water soluble soaps of selectively hydrogenated tallow acids as the emulsifying agent.

U.S.P. 2,470,447. Stabilization of Low Unsaturation Isoolefinic Polymers. C. F. Van Gilder to Standard Oil Development Company.

A mixture of an isoolefin and 0.1-5 percent of a polyalkylated phenol is polymerized at a temperature of 0° to —164° C. by the addition to the cold material of a Friedel-Crafts catalyst dissolved in a non-complex forming solvent which is liquid at the reaction temperature.

U.S.P. 2,470,629. Process of Emulsion Polymerizing Butadienes. G. P. Mack to Advance Solvents & Chemical Corporation.

Butadiene-1,3, isoprene, 2,3-dimethyl butadiene-1,3, or 2,3-halo-butadiene-1,3 or mixtures of these monomers with other monomeric vinyl compounds are emulsified with water in the presence of an emulsifier and of an emulsion stabilizer. This stabilizer is the condensation product of 3 mols of naphthalene beta-sodium sulfonate and 3 mols of a sodium sulfonate of a mixture of o-, m-, and p-terphenyl with 5 mols of formaldehyde. The resulting emulsion is heat polymerized.

U.S.P. 2,470,894. Production of Polyolefinic Hydrocarbons. W. W. Johnstone to Universal Oil Products Company.

Saturated hydrocarbons are contacted with HF at a temperature of —20° to 150° C., and a pressure sufficient to maintain at least a portion of the reaction mixture in the liquid phase. This mixture is separated into a hydrocarbon phase and an HF phase containing the polyolefins formed. The latter phase is distilled at a pressure not greater than 100 mm. absolute to separate the HF from the residual polyolefinic material consisting of hydrocarbons with conjugated or with non-conjugated unsaturation.

U.S.P. 2,470,904. Polymerization of Olefinic Hydrocarbons. W. B. Shanley to Universal Oil Products Company.

A hydrocarbon fraction containing more than 35 mol percent of olefins of higher mol. wt. than ethylene is passed at polymerizing temperature through a series of beds of solid catalyst of increasing thickness in the direction of

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flow. The hydrocarbons are cooled between successive catalyst beds by commingling a hydrocarbon quenching medium therewith. The effluent from the last bed is fractionated to separate polymers from unconverted hydrocarbons.

U.S.P. 2,471,034. Fluidized Catalytic Conversion of Hydrocarbons. R. E. Hall and M. J. Wilcox to Sinclair Refining Company.

In a fluid catalyst hydrocarbon conversion process, wherein a gaseous medium is passed upwardly in contact with a dense phase fluidized body of the catalyst in a contact zone, a plurality of such bodies is maintained interposed between alternate vertically spaced zones of lower catalyst density in which the catalyst is entrained in upwardly moving gaseous medium. Catalyst is introduced to the upper portion of the contact zone, is permitted to gravitate downwardly from a higher zone to the next lower zone through an annular space surrounding the rising gaseous stream, and is withdrawn from a lower portion of the contact zone. This method can be used in the conversion of hydrocarbon vapors as well as in the stripping of spent catalyst or in its regeneration.

U.S.P. 2,471,064. Stripping of Spent Catalyst in Hydrocarbon Conversion. R. E. Hall and M. J. Wilcox to Sinclair Refining Company.

The process of this patent is closely related to that of U.S.P. 2,471,034 in its particular application to the stripping of spent catalyst.

U.S.P. 2,471,084. Fluidized Catalytic Conversion of Hydrocarbons. M. J. Wilcox and R. E. Hall to Sinclair Refining Company.

The process of this patent is related to that of U.S.P. 2,471,034. The catalyst in suspension in hydrocarbon vapors to be converted, is passed into the lower end of a vertical reaction chamber of relatively large transverse dimension. The vapors are passed upwardly through a plurality of alternate zones of low and high velocity. Velocity conditions are claimed which permit establishment of zones of dense fluidized catalyst alternating with zones of lower density of the catalyst.

U.S.P. 2,471,085. Fluid Catalyst Process for the Conversion of Hydrocarbons. M. J. Wilcox and R. E. Hall to Sinclair Refining Company.

Another embodiment of the method according to U.S.P. 2,471,034 is claimed.

U.S.P. 2,471,234. Methylpentadiene-Aralkenyl Copolymers. R. C. Morris, A. V. Snider, and E. T. Bishop to Shell Development Company.

An elastomer of improved milling properties is produced by copolymerizing 0.1-10 percent of styrene, alpha-methylstyrene, or vinyl-naphthalene with 99.9-90 percent of a methyl-1,3-pentadiene in the presence of a Friedel-Crafts catalyst at a temperature below 75° C.

U.S.P. 2,471,398. Continuous Catalytic System. T. P. Simpson, J. W. Payne,

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and J. A. Crowley, Jr., to Socony-Vacuum Oil Company, Inc.

In a cyclic continuous process for the conversion of hydrocarbons in contact with a particle-form adsorbent catalyst passing downwardly through the reation zone, transfer of the catalyst from the regeneration to the reaction zone is permitted while substantial escape of hydrocarbon gas through the catalyst inlet is prevented without resorting to a vapor sealing valve. Details of the system are claimed.

U.S.P. 2,471,887. Stabilized Polymer. J. F. Nelson to Standard Oil Development Company.

A copolymer of isobutylene with a multiolefin of 4-6 C atoms is formed. It has a mol. wt. above 20,000 and contains a polyalkylated monophenol of particular constitution as a protective agent.

U.S.P. 2,471,890. Polymerization of Isobutylene in the Presence of Controlled amounts of Promoters for the Reaction. F. A. Palmer to Standard Oil Development Company.

A solution of an aluminum halide in an alkyl halide containing 0.04-0.5 g. of the Al halide per 100 cc. of solution is chilled to low temperature. 2-15 parts per million (based on the alkyl halide) of hydrogen halide are added and the chilled solution is then admixed to a moisture-free mixture comprising tert. olefin and alkyl halide chilled to —50 to —175° F. to effect polymerization of the olefin. Rubbery products are obtained.

U.S.P. 2,471,938. Ferrous Sulfate Pretreatment in Emulsion Polymerization of Conjugated Diolefins. W. W. Crouch and J. E. Pritchard to Phillips Petroleum Company.

In the emulsion polymerization of a conjugated diolefin, a ferrous salt is incorporated in the aqueous emulsion prior to the addition of a polymerization catalyst, and the mixture is maintained free of this catalyst for a pretreatment period (e.g. one hour). The rate of subsequent polymerization in the presence of an oxidizing-type catalyst is considerably increased by the pretreatment.

U.S.P. 2,471,959. Polymerizations Employing Azo Compounds as Catalysts. M. Hunt to E. I. du Pont de Nemours & Company.

Olefins are polymerized in the presence of a catalytic amount of cycloaliphatic azo compound containing an acyclic azo, —N=N—, group having bonded to each N atom a discrete tert. cycloliphatic C atom. One of the C atoms bonded to each of those tert. C atoms has all its remaining valences satisfied only by O or N. 1,1'-azodicyclohexanecarbonitrile is an example of this catalyst group.

U.S.P. 2,472,084. Carburetor Process for Acetylene Reactions. H. Beller, R. E. Christ, and F. Wuerth to General Aniline & Film Corporation.

Acetylene is made non-explosive for handling it safely in chemical reactions by saturating it with the vapors of a normally liquid organic diluent, such as aliphatic alcohol.

U.S.P. 2,472,085. Carburetor Process for Making N-Vinyl Compounds. H. Beller, R. E. Christ, and F. Wuerth to General Aniline & Film Corporation.

The method according to U.S.P. 2,472,084 is here employed in the production of N-vinyl compounds from pyrrole compounds or sec. N-diarylamines by acetylene in the presence of small amounts of strongly alkaline compounds.

U.S.P. 2,472,086. Carburetor Process for Acetylene Reactions. H. Beller, R. E. Christ, and F. Wuerth to General Aniline & Film Corporation.

The method according to U.S.P. 2,472,084 is here employed in the production of vinyl esters from organic carboxylic acids and acetylene. Volatile organic liquid diluents inert in this reaction or the volatile organic acids employed in the reaction itself are used as the diluents for acetylene.

U.S.P. 2,472,232. Butadiene Emulsion Polymerization in the Presence of a Glycol Monoether. W. A. Schulze and W. W. Crouch to Phillips Petroleum Company.

The emulsion polymerization of aliphatic conjugated diolefins is carried out in the presence of a minor proportion of a glycol monoether as promoter.

U.S.P. 2,472,254. Apparatus and Method for Carrying out Catalytic Reactions. A. J. Johnson to Shell Development Company.

Endothermic and exothermic catalytic reactions of hydrocarbons, e.g. dehydrogenation and hydrogenation, are simultaneously carried out by passing a hydrocarbon in the fluid state through a first reaction zone containing a catalyst for promoting an endothermic reaction and normally having a decreasing temperature gradient in the reaction. A molar excess (based upon the hydrocarbon) of a product of this endothermic reaction is fed to the reaction zone together with a minor amount of another hydrocarbon capable of reacting exothermically with said reaction product under the reaction conditions. Further details of this reaction and of the treatment of the resulting mixture in a second reaction zone are also claimed. aromatic hydrocarbons, e.g. toluene, can be produced by this method from hydroaromatic naphthenic hydrocarbons, e.g. methyl cyclohexane, with the addition of 0.1-0.5 mols of a normally liquid olefin, e.g. diisobutylene.

U.S.P. 2,472,494. Safety Fuel Ingredients and Their Preparation. O. C. Slotterbeck to Standard Oil Development Company.

A hydrocarbon product useful in a safety fuel is obtained from a C4 refinery cut containing iso- and n-butylenes by treatment with H_2SO_4 under certain conditions to form a final total polymer of particular composition from the butylenes. A codimer fraction of this polymer product is further polymerized.

U.S.P. 2,472,502. Apparatus for Stripping Finely Divided Solids. C. W. Tyson to Standard Oil Development Company.

An apparatus is claimed for stripping volatile material from solid particles, for example in the catalytic conversion of hydrocarbon. The stripping vessel is divided into sections arranged one above the other and separated by spaced horizontal perforated partition.

U.S.P. 2,472,537. Hydrocarbon Conversion with Fluidized Catalyst. T. B. Kimball to Sinclair Refining Company.

In a fluid catalyst process for the conversion of hydrocarbons, the spent catalyst is passed in suspension in the oxidizing gas into the lowermost zone of a regenerating chamber comprising at least three zones delineated by horizontal, perforated partitions. Catalyst from each zone except the lowermost is withdrawn, cooled, and returned to the zone just below that from which it was withdrawn. Catalyst from the uppermost zone is returned to the conversion chamber.

U.S.P. 2,472,589. Polymerization of Alpha Alkyl Styrenes. A. B. Hersberger to The Atlantic Refining Company.

An alpha alkyl styrene is polymerized by a Friedel-Crafts catayst in the presence of an inert polyalkylpolysiloxane solvent at a temperature below 10° C.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,470,092. Dehydrogenation Process. B. B. Corson and G. A. Webb to Koppers Company, Inc.

Aliphatic hydrocarbons and an aliphatic chain attached to aromatic hydrocarbons are dehydrogenated by contacting them in the presence of water vapor in a molal ratio less than 1:4 at a temperature of 500-750° C. with a catalyst containing at least 75 percent alumina impregnated with 1-3 percent nickel.

U.S.P. 2,470,216. Process for Synthesizing Motor Fuels of High Antiknock Value. P. C. Keith to Hydrocarbon Research, Inc.

In the synthesis of hydrocarbons from CO and H_2, the normally liquid hydrocarbons produced are passed in vapor phase in the presence of at least 2 mols of CO_2 for each mol of hydrocarbon in contact with a solid, mineral-type contact agent, such as bauxite, at elevated temperature (e.g. 700-950° F.). Gasoline hydrocarbons of improved antiknock value are obtained.

U.S.P. 2,471,129. Hydrocarbon Synthesis. H. G. Vesterdal to Standard Oil Development Company.

A mixture of CO and H_2 is contacted at elevated temperature with a catalyst consisting of a reduced form of iron oxide having incorporated therein a salt of fluoboric acid as a promoter. Hydrocarbons and oxygenated compounds are obtained.

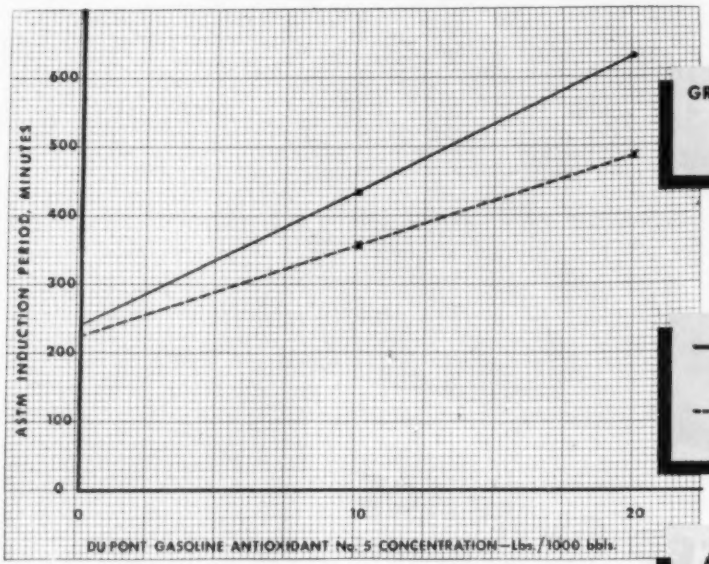
U.S.P. 2,471,130. Process of Preparing an Iron Catalyst Promoted with an Alkali Metal Fluoborate. H. G. Vesterdal to Standard Oil Development Company.

A catalyst as used in the process according to U. S. P. 2,471,129 is prepared by incorporating 0.2-10 percent by weight of an alkali metal fluoborate into

How one refiner*

Cut Gasoline Antioxidant Treating Costs 32%

with Du Pont Metal Deactivator



GRAPH SHOWING ANTIOXIDANT and METAL DEACTIVATOR RESPONSE

●——— Du Pont Gasoline Antioxidant No. 5 plus .25 lbs. per 1000 bbls. Du Pont Metal Deactivator

x--------- Du Pont Gasoline Antioxidant No. 5

This large refiner had been experiencing excessive gum formation in storage tanks. Ordinary analytical methods failed to show the presence of copper, but induction period tests demonstrated that copper was actually present in concentrations of less than 0.2 parts per million.

The use of Du Pont Metal Deactivator eliminated further trouble. The accompanying graph shows how with a Metal Deactivator concentration of only .25 lbs./1000 bbls. of gasoline it was possible to obtain a 400 minute induction period using 8.3 lbs. of antioxidant/1000 bbls. instead of 13.5 lbs./1000 bbls. without the use of Metal Deactivator—a total saving in treating costs of 32%.

Where copper is present, use Du Pont Metal Deactivator, the additive used by many refiners for years to economically control copper activity. For further information ask your Petroleum Chemicals representative or write the nearest District Office.

** Actual case taken from our files*

Antioxidant requirements for 1000 barrels of gasoline to meet 400 minute induction period

Du Pont Gasoline Antioxidant No. 5	13.5 lbs.
Du Pont Gasoline Antioxidant No. 5 plus 0.25 lbs. of Metal Deactivator per 1000 bbls.	8.3 lbs.
Net saving in cost through use of Du Pont Metal Deactivator	32%

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District Laboratories: Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; El Monte, Calif.

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iron oxide and then reducing at least a part of the iron oxide to metal.

U.S.P. 2,471,913. Treatment of Solid Diluent in Hydrocarbon Synthesis Process. S. D. Sumerford to Standard Oil Development Company.

An iron-type catalyst for the hydrocarbon synthesis from CO and H_2 is used in the fluidized state mixed with an inert fluidizable solid siliceous diluent previously treated with an acid, e.g. sand treated with a 3-12 normal HCl solution. While catalyst disintegration of the catalyst due to carbon formation resulting in loss of catylst fluidity is prevented by the addition of the siliceous diluent, acid pre-treatment of this diluent prevents loss in selectivity of the catalyst.

U.S.P. 2,471,914. Synthesizing Hydrocarbons. S. B. Sweetser to Standard Oil Development Company.

CO-H_2 mixture is contacted at elevated temperature with a powdered synthesis catalyst in a dense, fluidized suspension. The product is fractionated to obtain a naphtha fraction containing all the normally liquid hydrocarbons boiling up to 400° F. and a gas oil fraction boiling from 400-860° F. The naphtha fraction is aromatized and the gas oil fraction is catalytically cracked. Gasoline of improved octane rating is recovered from both these operations.

U.S.P. 2,472,219. Synthesis of Hydrocarbons. L. R. Lyons to Standard Oil Company of Indiana.

A hydrocarbon gas is converted into a mixture comprising H_2 and CO. This mixture is contacted with a synthesis catalyst to produce higher-mol.-wt. hydrocarbons and oxygenated compounds. The vaporous reaction product is partially condensed. Oxygenated hydrocarbon compounds are withdrawn and at least partially recycled to the hydrocarbon gas for reconversion to H_2 and CO.

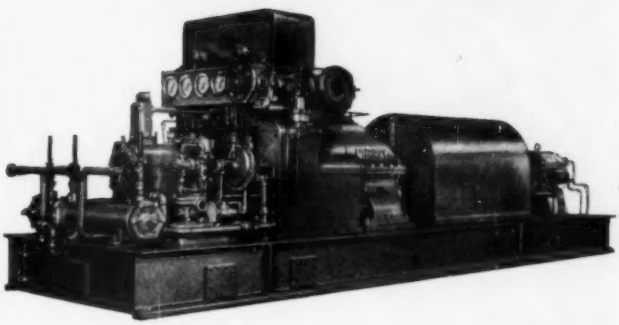
U.S.P. 2,472,377. Process for Hydrocarbon Synthesis. P. C. Keith to Hydrocarbon Research, Inc.

CO and H_2 are passed under reaction conditions upwards through a multiplicity of tubular reaction zones containing fluidized synthesis catalyst. Each of these zones has a transverse section within which the innermost catalyst particle is not less than about ½ inch and not more than 4 inches away from the periphery. Each zone is cooled. The catalyst mass is fluidized with an inert gaseous medium in a lower zone communicating with the reaction zones to ensure uniform fluidization in all reaction zones. The gaseous medium flows up concurrently with the synthesis gas.

U.S.P. 2,472,427. Hydrocarbon Synthesis with Fluidized Catalyst Regeneration. E. A. Johnson to Standard Oil Company of Indiana.

In the synthesis of normally liquid hydrocarbons a mixture of CO and H_2 is passed upwardly under synthesis conditions in contact with a large mass of catalyst of a particle size smaller than 200 microns and chiefly within the range of 2-100 microns. The gas mixture is passed upwards at a low velocity suffi-

MURRAY
TYPE D TURBO-GENERATOR



Murray Type D turbo-generators are built in a capacity range from 500-3000 KW. Turbines are either direct-connected to 2-pole generators or operate through reduction gears connected to 6-pole generators at 1200 RPM. Direct current and 25 cycle machines are also available. This type machine is regularly furnished in the above capacity range either condensing or non-condensing and may be of the automatic extraction type or for high back pressure. Units may be mounted either on soleplates or on a fabricated steel base.

This type turbo-generator is designed to operate on steam conditions up to 600#, 750° F. TT. Auxiliary equipment normally includes combined trip throttle valve, complete pressure lubrication system including oil tank, oil filter, coolers, and automatic turbine-driven auxiliary oil pump. Gauge board with gauges, vibrating reed tachometer and necessary thermometers are also furnished.

The above photograph shows a machine of this type rated at 1000 KW. Two duplicate machines are installed in our Nation's Capitol.

Murray turbo-generators have long been noted for their rugged construction, operating economy and long life with a minimum of maintenance.

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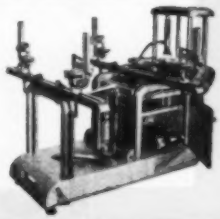

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Patents

cient to produce a liquid-like dense turbulent phase of the catalyst superimposed by a light dispersed phase. A portion of the catalyst is withdrawn from the dense phase below its upper level, regenerated with hydrogen and recycled.

DESULFURIZATION

U.S.P. 2,471,108. Treatment of Sulfur-Containing Hydrocarbons. B. N. Hill to Standard Oil Development Company.

Hydrocarbons are freed from sulfur and acidic constituents by contacting them with a mixture of clay, alkali sulfide, and alkali hydroxide. The water content of this mixture can be 30-50 percent by weight and its clay content 5-30 percent.

U.S.P. 2,471,153. Process of Treating Petroleum Oils with Copper Soap and of Producing the Copper Soap. C. O. Hoover to Air Reduction Company, Inc.

Petroleum oil is treated with a copper soap of water-insoluble organic acid for the fixation of sulfur compounds contained in the oils. Details of this method are claimed.

U.S.P. 2,472,253. Production of Cuprous Naphthenate in the Treatment of Petroleum Oil. C. O. Hoover to Air Reduction Company, Inc.

In the treatment of petroleum oil for the fixation of sulfur compounds by introducing a copper soap of a water-insoluble organic acid into the oil which is then heated with the liberation of vapors containing this acid, the liberated vapors are contacted with a finely-divided copper compound suspended in a fluid medium inert to the oil vapors and the organic acid. The thus freshly formed cuprous soap is used for the treatment of further amounts of oil.

U.S.P. 2,472,473. Conversion of Hydrosulfides to Neutral Sulfur Substances. L. C. Fetterly to Shell Development Company.

Spent aqueous alkaline solutions containing hydrosulfides or mercaptans extracted from sour hydrocarbons are contacted with an oxygen-containing oxidizing agent in the presence of a small amount of an amino-hydroxy-nitrobenzene catalyst containing attached to the benzene nucleus 3 polar amino or hydroxy groups, e.g. 2,6-diamino-4-nitrophenol.

PETROCHEMICALS

U.S.P. 2,469,848. Preparation of Fluorohydrocarbons. L. F. Salisbury to E. I. du Pont de Nemours & Company.

A gaseous mixture of HF and a hydrocarbon with a molecular weight not more than 80 and of the general formula $RC{=}CH$, wherein R is hydrogen, a monovalent saturated or enthylenicly unsaturated hydrocarbon radical, is passed under unhydrous conditions over a discrete catalyst body comprising a mer-

Patents

cury compound intimately associated with a solid organic polymer unaffected by the mercury compound and by anhydrous HF. A temperature is employed between 0° C. and that at which the polymer softens. A fluorohydrocarbon is produced.

U.S.P. 2,470,336. Halogenation of Aromatic Hydrocarbons. A. S. Brunjes and M. J. P. Bogart to The Lummus Company.

Details are claimed of a process for continuously chlorinating benzene to produce maximum amounts of monochlorbenzene and minimum amounts of polychlorbenzene with high conversion of benzene.

U.S.P. 2,471,102. Treatment of Microcrystalline Residues and Products Resulting Therefrom. J. J. Fish to Sun Chemical Corporation.

Petroleum microcrystalline residues, such as obtained by settling or fractionation from crudes and particularly from Texas crudes, are treated with an aluminum halide and then blown with air in the presence of halogenated hydrocarbon or a polymerized unsaturated hydrocarbon such as polyethylene. Hardness, penetration, setting, etc., of the material are improved by this treatment so that it is useful in the preparation of inks, crayon, coating, compositions, and the like.

U.S.P. 2,471,525. Reaction of an Acetylene with HF to Produce Vinyl Fluoride and/or Difluoroethane and Homologues Thereof. J. C. Hillyer and J. F. Wilson to Phillips Petroleum Company.

A mixture of an acetylene and a molar excess of HF is contacted with an AlF_3 or Al_2O_3 solid catalyst at elevated temperature. Fluoro hydrocarbons are obtained.

U.S.P. 2,471,570. Addition of Chlorinated Acetic Acid Derivatives to Olefins. M. S. Kharasch and W. H. Urry to U. S. Rubber Company.

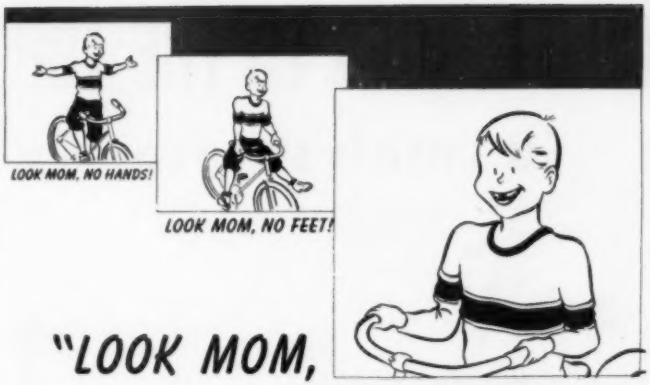
A mixture of an olefin of the formula $RCH=CH_2$ where R is a saturated hydrocarbon radical with 1-6 C atoms, e.g. octene-1, and at least one mol proportion of an acid chloride of a chloracetic acid, e.g. trichloro acetyl chloride, is reacted in the presence of a peroxide catalyst, such as diacetyl peroxide. Addition products of the components are formed, e.g. alpha, alpha, gamma-trichloro capryl chloride.

U.S.P. 2,471,766. Copolymer of Styrene and a Phenyl-Vinyl Acetate. D. T. Mowry and C. L. Mills, Jr., to Monsanto Chemical Company.

A mixture of 70-98 percent by weight of styrene and 30-2 percent of a phenyl-vinyl acetate of particular structure is heated in the presence of a peroxy catalyst at 50-200° C. Copolymers are obtained.

U.S.P. 2,471,785. Copolymers of Vinyl Aromatic Compounds. R. B. Seymour and J. M. Butler to Monsanto Chemical Company.

Styrene, alpha-methylstyrene, or alpha, para-dimethylstyrene are mixed with 5-95 percent of vinyl biphenyl, vinyl



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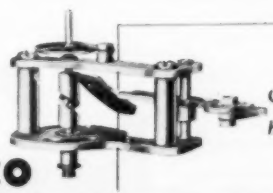

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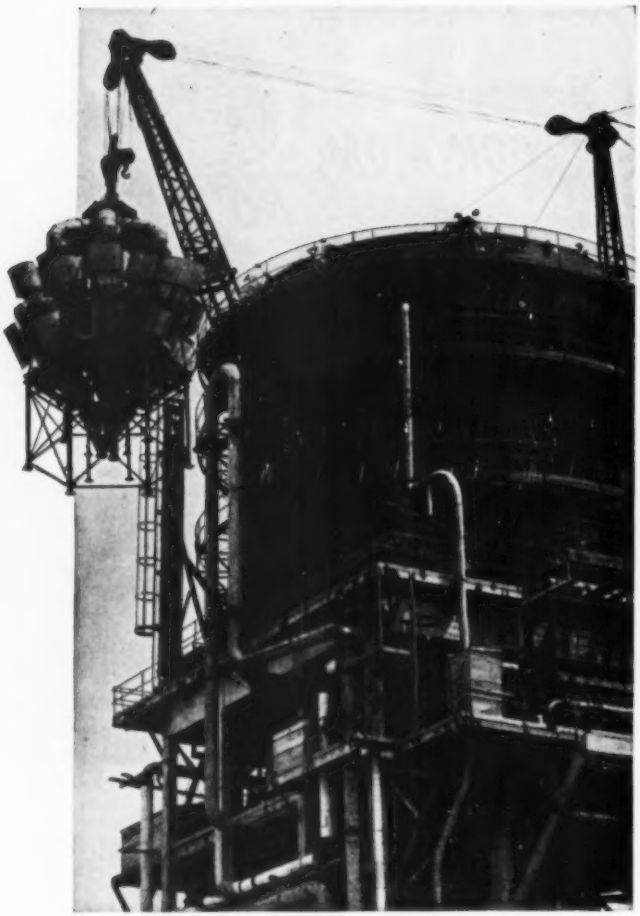

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DUST COLLECTION

MANUFACTURING IN UNITED STATES AND CANADA FOR SHIPMENT THROUGHOUT NORTH AND SOUTH AMERICA

Patents

chlorobiphenyl, or vinyl fluorobiphenyl and heat polymerized. Resinous materials useful in the plastics and coating industries are produced.

U.S.P. 2,471,853. Catalytic Partial Oxidation Process. L. K. Beach and G. C. Connolly to Standard Oil Development Company.

Aromatic hydrocarbons are contacted with solid particles of a catalyst-impregnated hydrous oxide gel adsorbent heat treated at a temperature above 700° C. Partial oxidation is effected such as production of phthalic anhydride from naphthalene.

U.S.P. 2,472,550. Manufacture of Organic Nitro Compounds. A. E. W. Smith, C. W. Scaife, and H. Baldock to Imperial Chemical Industries, Ltd.

At least one aliphatic mono-olefin with 3-6 C atoms is introduced into a solution of N_2O_4 in an organic, saturated, non-benzenoid solvent compound, the oxygen of this COH compound being only present in an ether group, and all ring systems thereof having at least 5 members. The N_2O_4 shall be in molar excess over the mono-olefin and be free from HNO_3 and NO. The solvent and any remaining nitrogen oxides are removed after the reaction by distillation at reduced pressure. The remaining reaction product is treated with water and the resulting dinitro paraffin is recovered from the non-aqueous layer by fractional distillation. 1,2-dinitropropane can thus be obtained from propene.

U.S.P. 2,472,618. Production of Ethyl Alcohol. A. S. Ramage to A. A. F. Maxwell.

Fifty-six parts ethylene are reacted with 64 parts SO_3 and 18 parts water under heat and pressure. Thirty-six parts by weight of water are then added to the reaction mixture in a closed pressure chamber, and the mixture is further heated to raise the temperature and pressure thereof. Ethyl alcohol is recovered thereafter by rectifying the reaction mixture. A small amount of Ag_2SO_4 can be added to the reaction as an accelerator.

U.S.P. 2,472,672. Vinyl Sulfone-Diene Interpolymers. C. J. Mighton to E. I. duPont de Nemours & Company.

Forty to eighty-five parts of a diene with conjugated double bonds in 1,3-position are emulsion copolymerized with 60-15 parts of a monovinylsulfone of the formula $RSO_2CH=CH_2$ in the presence of a water-soluble salt of an inorganic per-acid, an oxidizable sulfur compound, and an emulsifier.

HEAVY OILS AND WAXES

U.S.P. 2,470,276. Oil Addend. F. M. Watkins to Sinclair Refining Company.

Petroleum oil which is normally corrosive to copper due to its sulfur content is compounded with tert.-butyl hydroperoxide or p-cymene hydroperoxide to inhibit such corrosion.

from plan to plant

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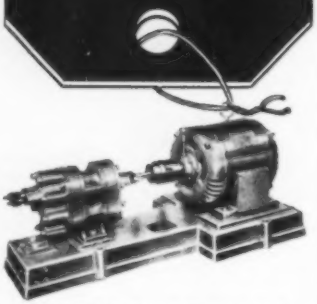

Sier-Bath Screw Pumps and Gearex Pumps are designed to do a job—and keep doing it. The manufacturer has a full appreciation of the high cost of interrupting the operation of a line to permit pump repairs. On the Internal Gear-type Screw Pump, for example, the gland is the only point of attention and as this is on the suction side, it is almost negligible. It is not unusual for the packing to last two years without repacking. The pressure on the gland is so slight that it is possible to add a new ring of packing without shutting down the unit. Send for information.

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Patents

U.S.P. 2,470,405. Cutting Fluid. H. L. Leland to Standard Oil Development Company.

A water emulsifiable cutting oil consists of about 70 percent by weight of mineral base oil, 5 percent of oleic acid ester of partially dehydrated sorbitol, 15 percent of the reaction product of palmitic acid ester of this dehydrated sorbitol with ethylene oxide, and 10 percent of tricresyl phosphate. Stable emulstions can be obtained with this combination.

U.S.P. 2,470,537. Mineral Oil Compositions. S. P. Waugh to Tide Water Associated Oil Company.

A mineral oil composition contains dissolved therein 1-15 percent by weight of a blown semi-drying fatty oil, 0.05-1 percent of a hexitol anhydride partially esterified with a fatty acid of at least 12 C atoms, and 0.05-1 percent of a polyoxyalkylene derivative of such an anhydride partially esterified with such an acid.

U.S.P. 2,470,965. Manufacture of Grease. H. A. Woods, L. Klingen, and R. C. Barton to Shell Development Company.

Details are claimed of a process for preparing a lithium soap grease from mineral lubricating oil and lithium stearate or the like.

U.S.P. 2,471,115. Lubricating Oil. L. A. Mikeska to Standard Oil Development Company.

An oil-soluble additive for mineral lubricating oil to impart pour stabilizing properties to the oil is obtained by reacting a mixture of equal mol proportions of paraffin wax-phenol and decanol, or another high molal weight monohydroxy alcohol, with P_2S_5, and treating the dithiophosphoric acids thus formed with KI_3, SCl_2, or S_2Cl_2.

U.S.P. 2,471,889. Rust Preventive Compositions. M. A. Paliwoda and G. W. Duncan to Standard Oil Development Company.

A coating composition consists of 50-80 percent of a naphtha with a flashing point of 90-110° F., 10-15 percent pentaerythritol monostearate triacetate, or the like, and 10-20 percent of a non-volatile oily plasticizer.

U.S.P. 2,472,298. Cleaning, Penetrating, and Corrosion Loosening Composition. C. A. Jensen.

A mixture of about 25 percent mineral lubricating oil and 75 percent kerosine is compounded in certain proportion with PCl_3 to produce a cleansing, penetrating, and corrosion loosening composition.

U.S.P. 2,472,318. Inhibitor. P. Subkow.

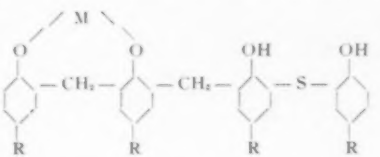
A mineral lubricating oil is mixed with a small amount of a compound of the formula PSR'SR, where R is a substituted or unsubstituted aryl or alkyl aryl group and R' is methyl or ethyl, to inhibit oxidation of the oil.

U.S.P. 2,472,503. Lubricating Oil Compositions. J. L. van der Minne to Shell Development Company.

A mineral lubricating oil is compounded with an oil-soluble polyvalent metal salt of an acidic aromatic carboxylic acid or phenol, and a saponified oxidation product of a polymeric olefin of lubricating oil viscosity obtained in a particular manner. The additives inhibit oxidation and corrosion.

U.S.P. 2,472,517-8. Addition Agents for Mineral Oil Lubricants. T. L. Cantrell and H. G. Smith to Gulf Oil Corporation.

Addition agents which confer improved bearing-corrosion-inhibiting and detergent properties on mineral oil lubricants are salts of the formula:

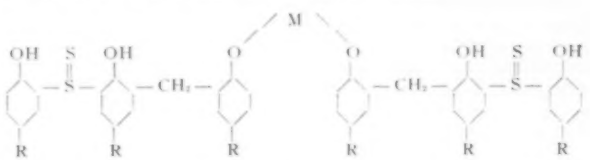


wherein R is an alkyl radical with 4-12 C atoms, and M is a divalent metal. They are prepared by condensing one mol of a divalent metal salt of a phenol having a p-alkyl substituent of 4-12 C atoms, 2 mols of formaldehyde, and one mol of a phenol sulfide obtained by correspondingly reacting 2 mols of such a phenol with one mol of SCl_2.

According to U.S.P. 2,472,518 the corresponding disulfide compound can be used for the same purpose and prepared correspondingly with the employment of S_2Cl_2 instead of SCl_2.

U.S.P. 2,472,552. Addition Agents for Mineral Oil Lubricants. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A lubricating mineral oil additive similar to that of U.S.P. 2,472,518 and having the formula



is obtained in a manner corresponding to that described in that patent. Only one mol of formaldehyde is employed in the preparation, instead of the two mols required in the other patent.

Douglas Oil Names Stevens

J. G. Stevens has been elected executive vice president and treasurer of Douglas Oil Company of California. He was formerly vice president and treasurer.

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REFINER

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of PETROLEUM REFINER

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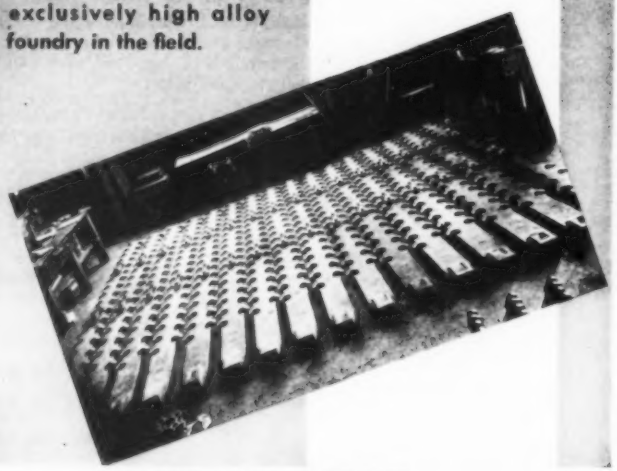

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BOOKS

Founders' Society Offers Steel Castings Booklet

Steel Founders' Society of America's booklet, "The Steel Castings Industry," describes the versatility, strength and dependability of steel castings for use in construction equipment, the petroleum industry, rolling mills and blast furnaces, metal working equipment, and machines and tools. Each industrial group is represented with pictures of the types of castings employed. Other groups represented are the railroads, aircraft, motor vehicles, power plants, electrical equipment, shipbuilding and ordnance.

A definite table contains comparative data on wages and hours. Other statistical material shows the industry's importance as a buyer of raw materials. Steel castings which were cut in weight by 15 percent and reduced in production costs by 18 percent are described in graphic form. Another section reports on the comprehensive co-operative research program developed by the society. Enclosed with the booklet is an envelope folder incorporating a new tabulation of the general engineering types of steel castings, classified according to tensile strengths.

Copies are made available from F. Kermit Donaldson, executive vice president of Steel Founders' Society of America, 920 Midland Building, Cleveland, Ohio.

Bureau Booklet Presents Screw Thread Standards

The proceedings of the 1948 National Bureau of Standards meeting which unified American, British and Canadian standard systems of screw threads have been presented in a booklet "Unified Screw Thread Standards." Illustrations, tables and numerical data setting forth standards of thread form are included.

The present unification agreement provides a 60-degree angle and a rounded root for screw threads with either flat or rounded external thread crests. The number of threads per inch for the various series of thread diameters has been unified, and the limiting dimensions for three grades to fit have been agreed upon.

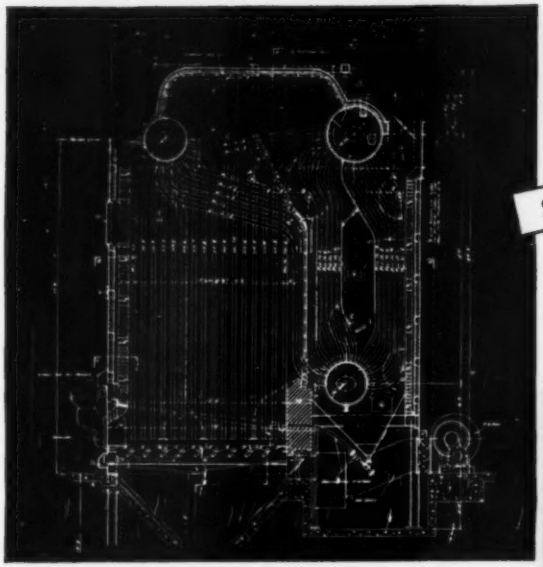
A copy of the booklet can be obtained for 30 cents by writing Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., referring to Circular 479, "United Screw Thread Standards."

"Consulting Services"

Association of Consulting Chemists and Chemical Engineers, Inc., a clearing house for consultants, has presented an amended and enlarged edition of "Classified Directory" under the name of "Consulting Services."

A copy of this twelfth edition may be obtained by writing Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st St., New York 17, N. Y.

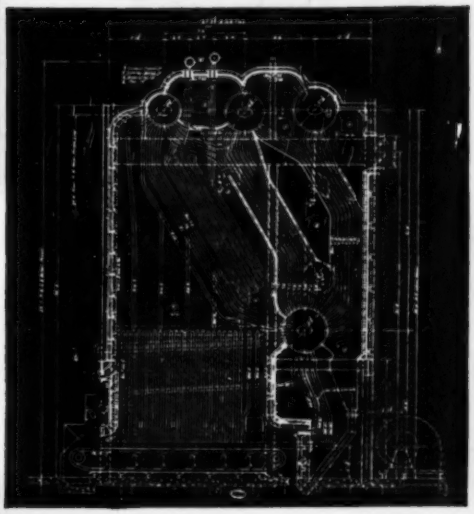
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY **Vogt**

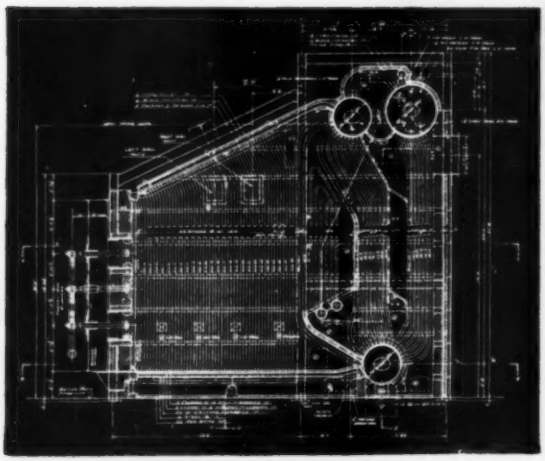
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.
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The water sides of fifteen tube and shell condensers in a West Texas refinery were almost plugged by heavy scale deposits. Dowell was called in to clean them. After a six hour soaking with specially selected Dowell solvents, they were flushed out and returned to service. Following this chemical cleaning, gasoline left the condensers 20°F cooler than after a previous mechanical cleaning. *The improvement in operating economy paid for the job in 12½ days!*

When you specify Dowell Chemical Scale Removal Service for your cleaning job, you get fast, convenient service. No scaffolding or dismantling of the equipment is required. Special solvents designed to dissolve or disintegrate the insulating scale are pumped in and out through existing connections. Costly down time is minimized.

Experienced Dowell engineers do the job. They bring the essential equipment — truck-mounted tanks, pumps, heaters, and chemical proportioners — to make possible step by step control of the work. Call the nearest Dowell office for fast, practical and economical removal of scale and sludge from all types of heat exchange equipment, steam generators, water lines and water wells. Free cost estimates gladly given.

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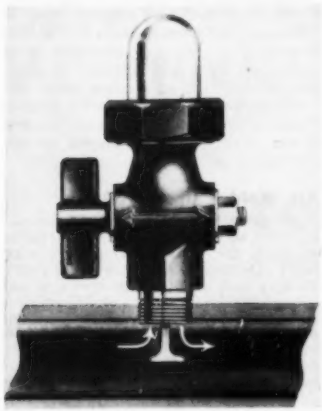
NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information on products described on these pages write to the address shown, using the number shown for each item.

Sight Glass With Valve (Item 395)



The clarity or turbidity of transparent liquids flowing under pressure through pipe lines can be observed through a valve type sight glass manufactured by Worthington Pump and Machinery Corporation. Differential pressure is established across the deflector to allow some of the liquid to circulate continuously through a glass observation bowl, which can be removed for cleaning. The sight glass can be used in any system through which transparent liquids flow including hot water.

For further information write Worthington Pump and Machinery Corporation, Harrison, N. J., referring by number to this PETROLEUM REFINER item.

Snubbers (Item 396)

"Slug Buster Snubber," a device to reduce excessive noise from engine exhausts and vacuum pump discharges to the noise level of the surrounding area, has been developed by Burgess-Manning Company. The machine is also useful for silencing compressor, blower and steam discharge as well as in power plants, sewage disposal plants and engine test stands.

For further information write Burgess-Manning Company, Libertyville, Ill., referring by number to this PETROLEUM REFINER item.

Caustic Diluter (Item 397)

One of the features of a continuous caustic diluter, made by %Proportioneers, Inc.% is a range of more than 10 to 1. Sizes of diluters cover from less than one gallon per minute to over 200 gpm. strong caustic. The impulse motor is positively controlled by the pilot valve in relation to the flow of diluting water. Accuracies within plus or minus 1½ percent at all flows within the range of the equipment are claimed. Other features include the pacing Treet-O-Control meter, and caustic Vol-U-meter and controls. The diluter continuously delivers diluted caustic of any desired strength using 50 percent liquid caustic from storage.

For further information write %Proportioneers, Inc.%, 9 Codding Street, Providence 1, R. I., referring by number to this PETROLEUM REFINER item.

Gravitometers (Item 398)

Bulletin 111R of American Recording Chart Company describes Arco-Anubis liquid gravitometers for pipelines, refineries, gasoline and chemical plants. Graphs and installation diagrams are included in explanations of the standard instrument and the controlling recording liquid gravitometer for use in the petroleum, chemical and food industries.

For a copy write American Recording Chart Company, 3113 East 11th Street, Los Angeles 23, referring by number to this PETROLEUM REFINER item.

Wedge Gage Illuminators (Item 399)

Built in accordance with Underwriters Laboratories' standard for electric lighting fixtures, a solid-wedge type gage illuminator is presented by Jerguson Gage & Valve Company in an explosion-proof unit. It incorporates the principle of solid-wedge lighting in combination with plastic, whereby the illumination from a single light source is reflected from an angular surface and flows with evenly diffused intensity through the transparent gage glass. "Only one bulb is necessary to illuminate two gage sections with the double-section illuminator." Aluminum brackets are equipped on the top two cover bolts of the gage section for mounting.

For further information write Jerguson Gage & Valve Company, 80 Fellsway, Somerville 45, Mass., referring by number to this PETROLEUM REFINER item.

Tachometer (Item 400)

A precision tachometer for accurate measurement of high speeds is announced by General Electric Company in publication GEC-560. The tachometer consists of a high-frequency pulse generator or pick-up, an electronic counting circuit, and two speed-indicating units: one for "on the spot" readings and the other for remote readings. The indicators do the calculation and interpolation, and flash on an opal glass screen, in figures approximately one inch high, the number of revolutions per minute. A reading is taken every second. The counting operation requires 8/10 second, while the calculation, interpolation, and indication use the remaining 2/10 second of the cycle. The counting circuit is housed in a 200-pound cabinet and the speed indicator is in a separate cabinet. The tachometer generator weighs about five pounds.

For a copy write General Electric Company, Schenectady 5, N. Y., referring by number to this PETROLEUM REFINER item.

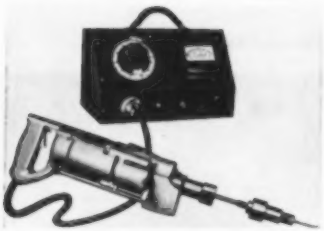
Regulating Valves (Item 401)

Minneapolis-Honeywell Regulator Company is offering the following bulletins: No. 242-1, featuring hi-lift v-port indicating type hand control valves, with schematic drawings describing valve design and parts giving data on sizes, etc.; No. 48-1, describing both direct connected and air activated liquid level controllers with details of special construction features and typical applications and also schematic drawings, capacity charts, etc.; No. 700-1, descriptions of the diaphragm motor controlled valve with radiation fins and positioner, the direct acting and reverse acting diaphragm motor controlled valve with manual operator, the supersensitive pilot-operated valve, the Venturi throa and other valves, etc.,

and No. 10-1, which describes regulating valves for water, steam, air, gas or oil float valves.

For copies write Minneapolis-Honeywell Regulator Company, Wayne and Roberts Avenues, Philadelphia 44, referring by number to this PETROLEUM REFINER item.

Tube Rolling Control (Item 402)



An Airetool-Fisher electric tube rolling control of Airetool Manufacturing Company, consists of the control mechanism, operated with a dial calibrated for the known expansion "peak" of each type of metal; an electric expander driving motor; and either a G-800 or G-1200 ball-bearing type condenser and heat exchanger tube expander. Using 110-volt, 60-cycle current, the control may be plugged into any outlet and can also be furnished for d.c. The dial is then turned to the setting which has been pre-determined by scientific tests for the type of metal to be rolled. When the maximum torque is reached, the control automatically cuts off the power, the motor reverses, and the operator may then withdraw the expander and go on to the next tube.

For further information write Airetool Manufacturing Company, 316 South Center Street, Springfield, Ohio, referring by number to this PETROLEUM REFINER item.

Plastic Products (Item 403)

E. F. Houghton & Company folder entitled "Houghton Serves the Plastic Industry" describes hydraulic oils, lubricants and leather packings used by plastic molders. The company's products and specialized services are outlined and also featured are the packings used in injection molding machines where pressures are extremely high and the action is high speed.

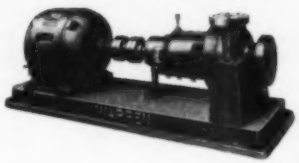
For a copy write E. F. Houghton & Company, 303 W. Lehigh Avenue, Philadelphia, referring by number to this PETROLEUM REFINER item.

Check Valves (Item 404)

Bulletin 105 of Falcon Products, Inc., describes the company's swing check valve and its triple action safety quick-closing valve. Sectional drawings, installation views, complete details and prices are included.

For a copy write Falcon Products, Inc., 949 East Second Street, Pamona, Calif., referring by number to this PETROLEUM REFINER item.

Process Pump (Item 405)



Warren Steam Pump Company, Inc., has added to its line of both centrifugal and reciprocating pumps, a new line of process pumps identified as RL Type. These pumps handle hot oil and other liquids up to 800° F. Capacities range to 1200 gpm., differential heads to 750 feet. According to the announcement these pumps are especially adapted to gasoline, hot oil, butane, propane, acids, etc.

For further information write Warren Steam Pump Company, Inc., Warren, Mass., referring by number to this PETROLEUM REFINER item.

Arc Welder (Item 406)

Air Reduction Sales Company has announced an a.c.-transformer arc welding machine, the Wilson 200 ampere max. MCT. Designed for use by small shops, garages and maintenance crews, it has a rated maximum output of 200 amperes and is self-contained. Welding range is divided into two ranges of current adjustment with stepless control throughout each range. Capacitors are supplied in the secondary circuit and built-in

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TIME TESTED—ENGINEERED TO MEET THE MOST RIGID TESTS

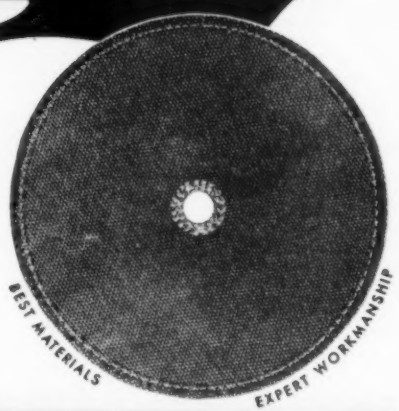
Schott Brothers have been manufacturing wax press Filter Blankets for a great number of the nation's refineries for many years.

Our particular blankets have been accepted and approved in the refining trade. They are constructed to meet the most grueling conditions and rigid tests.

We can also produce filter blankets per your particular specifications. Large capacity will assure you of prompt delivery.

Write us for further information. Prices and samples on request. We will be very glad to assist on any filter problem you may have.

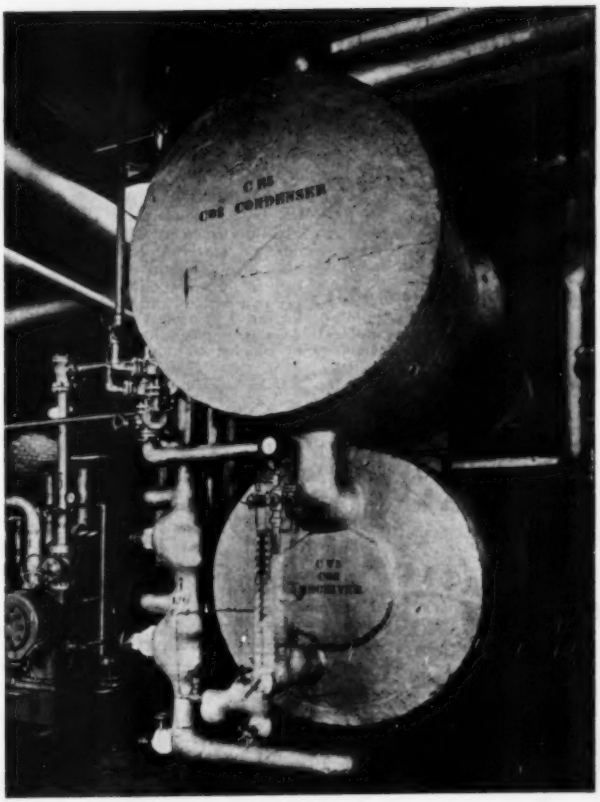
SIDEVIEW



THE SCHOTT BROS. CO., INC.

WEST SALEM, OHIO, U. S. A.

Lummus-built CO_2 condenser helps PURECO TURN ON THE COLD



At its new Chicago plant, Pure Carbonic, Incorporated, can produce 140 tons per day of solid carbon dioxide at high levels of efficiency.

Completely modern, and designed to save on service expense, the new plant includes long-lived Lummus-built equipment for two critical heat transfer tasks.

Shown above is a kettle-type all steel CO_2 condenser with 3200 sq. ft. of tubular surface. The same plant includes a Lummus-built heat exchanger for CO_2 and ammonia, having 355 sq. ft. of tubular surface, with seamless stainless steel tubes.

Heat transfer equipment by Lummus is the choice of performance-minded engineers throughout the power and process industries. Lummus has an unique background of experience on both conventional and highly specialized units involving top limits of pressure, temperature and corrosive conditions.

Write for new bulletin—Lummus Heat Transfer Equipment (Bulletin M 303) is a new 16-page publication giving details, design data, and application information. For your copy, address The Lummus Company, Heat Exchanger Division, 259 West 14th Street, New York 11, New York.

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capacitors in the primary circuit provides power factor correction. Windings are fully insulated with heat-resistant spun-glass fibre. A primary "on and off" switch and a 10-foot length of three conductor rubber covered primary cable with lugs attached are included with the machine.

For further information write Air Reduction Sales Company, 60 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

Ratio Speed Changer (Item 407)

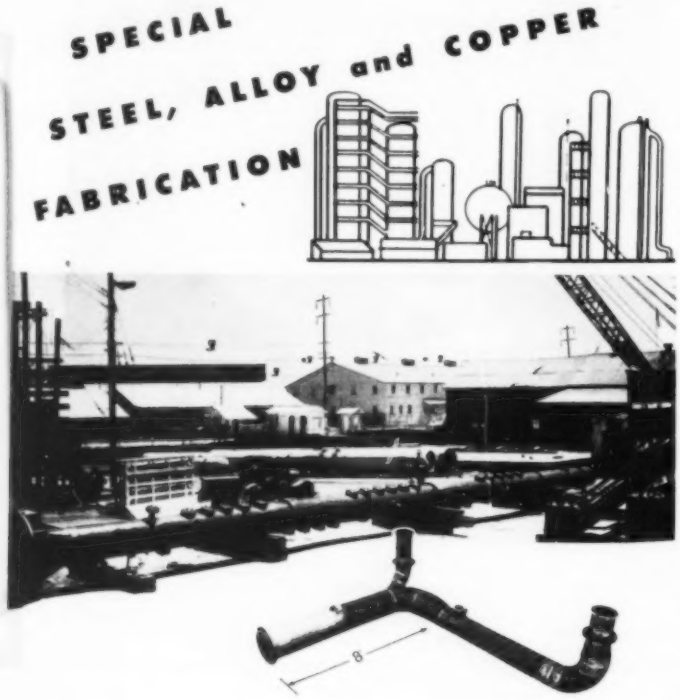
Metron Instrument Company's Bulletin 99 describes a miniature variable-ratio speed changer with adjustable-speed drive, operating principle, applications, and design features. Dimensional drawings, and characteristic curves also are included.

For a copy write Metron Instrument Company, 432 Lincoln Street, Denver 9, Col., referring by number to this PETROLEUM REFINER item.

Grid Trays (Item 408)

Applications of grid trays for handling filtering material are described in Catalog G-48, published by Kerlow Steel Flooring Company. Dimensions of eight different patterns of grid trays, a safe load table and other engineering data to help in the selection of trays are given.

For a copy of the catalog, write Kerlow Steel Flooring Company, 220 Culver Avenue, Jersey City 5, N. J., referring by number to this PETROLEUM REFINER item.



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PIPE LINE PUMP STATIONS AND
GAS PROCESSING PLANTS

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SHIPBUILDING CO. · ORANGE, TEXAS

Fluid-Motor Operator (Item 409)

A fluid-motor operator for gate valves which can be operated by water, oil or compressed air or gases at pressures from 40 to 300 psi., is announced by Crane Company. Valves equipped with the operator are available in sizes from 4 to 30-inch. A handwheel is furnished for manual operation in the event of pressure failure. The motor unit, comprising the motor, gear box and yoke, is bolted to the valve bonnet and the motor operates the valve stem through the gear box. The motor derives its power from five flexible diaphragms, mounted radially about an eccentric on the drive shaft. The operating fluid is admitted in rotational sequence to the five diaphragms, which actuate pistons that transmit the thrust to the eccentric through a roller bearing mounted on the shaft. By means of a suitable control, the operating fluid can be admitted either of two entrance ports, controlling the direction of operation of the motor for opening and closing the valve.

For further information write Crane Company, 836 S. Michigan Ave., Chicago 5, referring by number to this PETROLEUM REFINER item.

Welding Fittings (Item 410)

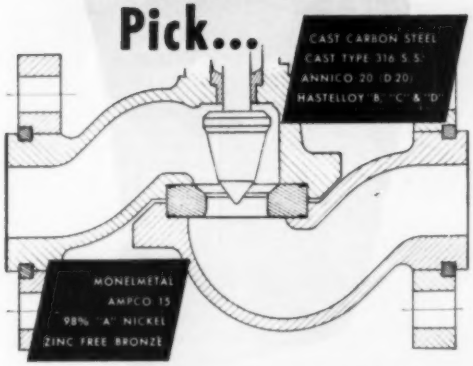
Complete specifications and list prices of a newly expanded line of Flowline stainless steel welding fittings in five different ranges of wall thicknesses and sizes, and in three different stainless alloys are given in Bulletin S-310 of Welding Fittings Corporation. Standard fittings include 90° and 45° elbows, 100° returns, lap joint stub ends, straight tees, and concentric reducers. Special fittings of outlet tees, eccentric reducers, welding laterals, and welding crosses can be made to order.

For further information write Welding Fittings Corporation, New Castle, Pa., referring by number to this PETROLEUM REFINER item.

Sheet Packing (Item 411)

A palmetto compressed asbestos sheet packing developed to the requirements of Army-Navy aeronautical specification AN-G-171, has been offered by Greene,

Take Your Pick...



THERE'S AN ANNIN SINGLE SEAT DOMOTOR VALVE IN THE ALLOY YOU NEED

Annin Domotor Valves are available in almost any castable alloy to meet every installation requirement. Regardless of the fluids you are handling, whether they are corrosive, erosive or gaseous, there is an Annin Domotor Valve in the alloy that will give most efficient service and longest valve life.

Field-proven Annin Domotor Valves provide smooth, positive control accurate to .0005 in pressure impulse response. Straight, smooth flow passages in the exclusive single seat valve body eliminate turbulence and afford full flow capacity with low pressure drop. Simple, separable valve construction provides fast, on-the-job inspection or replacement of the simple, threadless valve trim. The two-piece valve body may be rotated in assembly to form a right-hand, left-hand angle or straight through pattern. Interchangeable line flanges make possible the use of a single valve anywhere in the plant regardless of system pressure. Sizes are from ¾" to 4". Temperature range: −300° F. to 1000° F.; pressure to 2500 lbs.

Look for Annin Domotor Valves at the I.S.A. show in St. Louis, September 12th to 16th.

Write today for this bulletin.

A new bulletin showing installation and operating features of the Domotor Valve will be sent to you upon request.

THE ANNIN COMPANY
3234 Mines Avenue
Los Angeles, California

ANNIN DOMOTOR VALVES

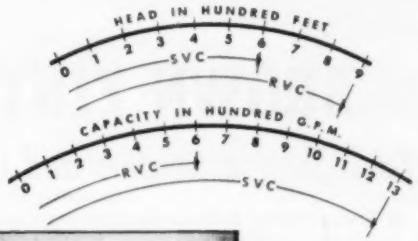
Investigate Annin DOMOTOR VALVES *Valves*

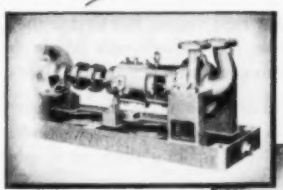
Job too TOUGH for ordinary pumps ?

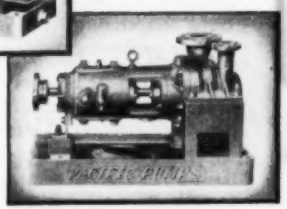
then specify Pacific

SVC SINGLE STAGE
RVC TWO STAGE
CENTRIFUGAL PUMPS

Engineered for the tough job...
Extra heavy parts fabricated from the toughest materials







TYPE SVC ◇ *Write for Bulletin 85*

TYPE RVC ◇ *Write for Bulletin 101*

PACIFIC *Precision Built* PUMPS

25th ANNIVERSARY

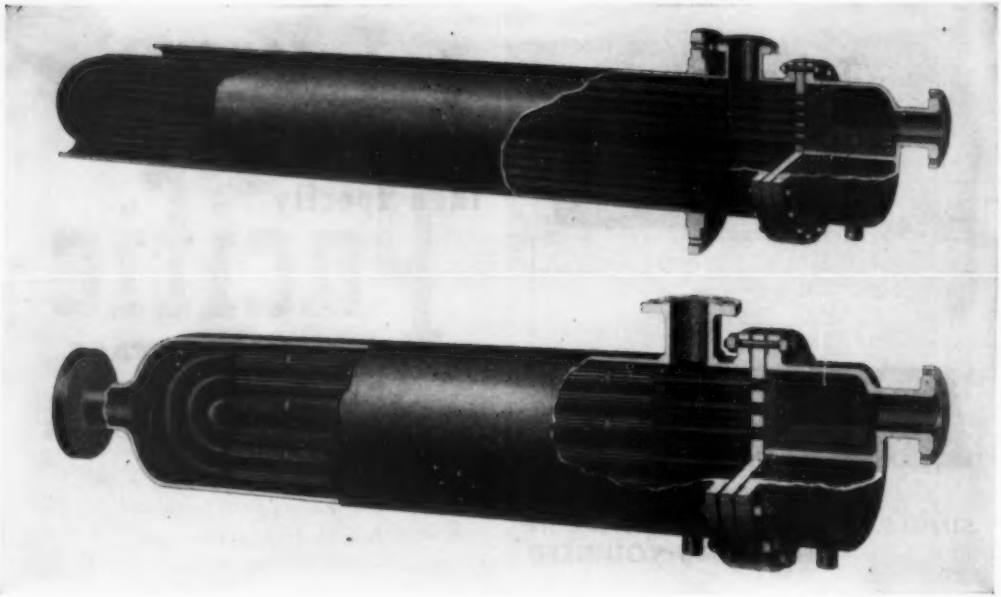
Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York
Offices in All Principal Cities

PR-7



BROWN FINTUBE

Tank Suction Heaters and Line Heaters

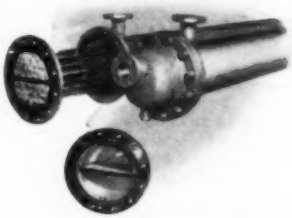
● Brown Fintube Tank Suction Heaters are moderately priced and highly efficient. They heat viscous oils so that they can be pumped more easily, and bolt or weld to a tank nozzle, or directly to the tank shell, so all piping and connections are made outside the tank.

The Line Heaters are used as Suction Heaters to permit easier pumping of viscous oils; — or as Pressure Heaters, either to overcome temperature losses in long lines, or to preheat liquids for further processing.

In all cases the bundles consist of Brown Fintube hairpins rolled into the tube sheet in full compliance with the ASME codes. Metal bands, placed around alternate fintubes, prevent the longitudinal fins from interlocking and restricting the flow. This construction avoids baffling, and permits the liquids being heated to pass through the bundle *unobstructed*, in close contact with the fins and center tubes, with *low pressure drop*. Wide range of standard sizes.

Send for Bulletin No. 482. It gives full details.
Let us quote on your requirements.

Brown Fintube Hairpin Bundles Showing the Banding of Alternate Tubes that Eliminates Baffles and Assures Unobstructed Flow.



Hairpin Bundle Assembled in Shell Showing Mounting of Tube Sheet Between the Shell and Head.

THE BROWN FINTUBE CO.
ELYRIA, OHIO

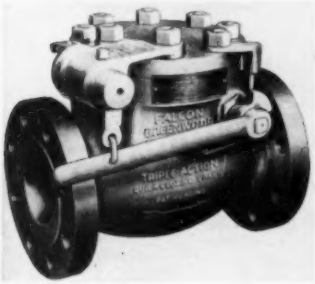
FINTUBE HEAT TRANSFER PRODUCTS

New Equipment

Tweed & Company. Combining strong resistance to heat, oil, and solvents, the packing has particular resistance to alcohol-water mixtures and ethylene glycol water mixtures which tend to swell other sheet packing. With asbestos fibres sealed to prevent water absorption, the packing is also resistant to refrigerants such as freon. It has tensile strength with the grain of 6150, and after oil immersion, 7100. Test bends of 180° have been made. The material has a compressibility of 10 percent under 1000 psi. and 99 percent at recovery.

For further information write Greene, Tweed & Company, North Wales, Pa., referring by number to this PETROLEUM REFINER item.

Quick Closing Valve (Item 412)



Built on Greenwood patents, the Falcon-Greenwood quick closing valve of Falcon Products, Inc. is described in Bulletin No. 105. It operates either automatically or manually instantly to shut off the flow of gasoline or natural gas within the refinery, butane plant or other fire hazardous units. Built for high pressure work, it is available in 2 to 8-inch sizes in steel, monel or stainless steel trim. The shut-off gate may be operated either automatically through a fusible link, through a hydraulic or pressure system, or manually by means of a pull system.

For a copy write Falcon Products, Inc., 949-969 East Second Street, Pomona, Calif., referring by number to this PETROLEUM REFINER item.

Glassware (Item 413)

"Plant Equipment for the Process Industries," a bulletin of Corning Glass Works, describes the following: Pyrex brand tubing, brand precision bore tubing, brand cylinders, brand glass heat exchangers (candle cooler and jacketed), brand plate and flat glass, brand glass pipe, gauge and brand sight glasses; Vycor vessels, cylinders, tubing, flat glass and rods; and Corning multiform glassware including gauge glasses.

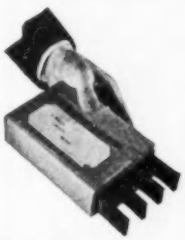
For a copy write Plant Equipment Sales Department, Corning Glass Works, Corning, N. Y., referring by number to this PETROLEUM REFINER item.

Fiberglas Wrap (Item 414)

A high-strength Fiberglas wrap for underground pipe lines is presented by Owens-Corning Fiberglas Corporation.

WHICH ADVANTAGE

is most important to you when specifying grating?



1 Rigid one-piece construction—easy to install?

2 Maximum open area for light and air?

3 Easy to paint—all surfaces accessible?

4 Non-slip Twisted Cross-Bar?

5 Self-cleaning—no sharp corners to clog?

Blaw-Knox Grating Has Them All!

WRITE TODAY . . .

For this "paper-weight-size sample" on your business letterhead, so that you can have a "close-up" of Blaw-Knox Grating Construction.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2005 Farmers Bank Bldg., Pittsburgh 22, Pa.
Offices in Principal Cities

BLAW-KNOX ELECTROFORGED STEEL GRATING

Another FALCON Product

FALCON-GREENWOOD
VERTICAL SWING
HORIZONTAL CHECK VALVE

HIGH PRESSURE
FREE FLOW NO "CHATTERING"

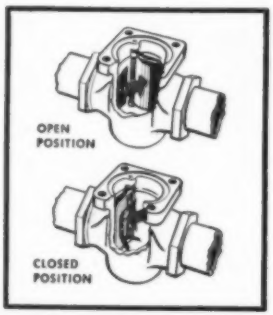
Here's a cast steel high pressure Swing Check Valve for oil, gas, steam and water that will not "chatter" or knock and therefore will outlast ordinary check valves many times.

The gate mounted on a vertical pivot pin does not float on the liquid or gas and its weight therefore is not a factor in closing the valve. NO FLOATING – NO "CHATTERING" – NO WEARING.

When flow ceases or is reversed a flat spring on back of gate forces it closed instantly.

Made of cast steel with large free-flow passage-ways, the Falcon-Greenwood Vertical Horizontal Swing Check Valve is available in sizes from 2" to 8".

Send for Bulletin No. 101



OTHER FALCON PRODUCTS

★ SLUSH PUMP LINERS
★ LINER SLEEVES
★ PISTON RODS
★ SWIVEL WASH PIPES
★ INTERLOCK GLAND PACKING

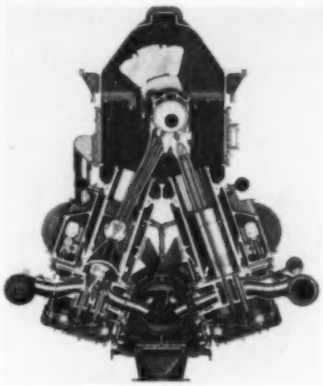
Falcon Products are sold through leading supply houses everywhere

FALCON PRODUCTS, INC.
949-969 EAST SECOND STREET · POMONA, CALIFORNIA
BRANCH WAREHOUSES: HOUSTON · ODESSA · WICHITA FALLS · OKLAHOMA CITY
SHREVEPORT & JEANERETTE, LA. · CASPER · RANGELY · BAKERSFIELD · TURNER VALLEY, CAN.
Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

New Equipment

Known as "coromat," the new porous wrap of glass fibers is reinforced with long continuous strands of glass yarns which are made from fine, flexible, textile-type filaments of glass designed to resist soil acids and electrolytic action. With yarns in a multi-directional pattern, the tear strength of the basic fiberglas pipe wrap has been increased 200 to 400 percent. One thousand or 1200-foot rolls can be used without frequent machine stoppages to add new rolls.

For further information write Owens-Corning Corporation, Toledo 1, Ohio, referring by number to this PETROLEUM REFINER item.



V-Type Diesel (Item 415)

Operating either as a conventional oil-burning diesel gas engine or as a gas-diesel unit, V-type diesels of The Cooper-Bessemer Corporation, are reported to deliver more horsepower per cubic foot of space. Engines are 16-cylinder, gas-diesel units rated 3300 h.p. per unit at 327 rpm. Requiring 275 square feet of floor space or 12 h.p. per square foot, the engine compares with 9 h.p. per square foot as produced by other engines. Built with two banks of cylinders, 15¼-inch bore and 22-inch stroke, it drives a single crankshaft by means of articulated connecting rods. Other features include low bearing pressures, motor-driven pumps, dual superchargers, low head room and 13½-inch diameter crankshaft.

For further information write The Cooper-Bessemer Corporation, Mt. Vernon, Ohio, referring by number to this PETROLEUM REFINER item.

Blower (Item 416)

Stoker Division works of The Standard Stoker Company, Inc., has manufactured the "Standaire Blower" featuring the axial flow principle in a positive displacement unit. It has capacities for handling gas or air under pressure or vacuum from 20 cfm. to 15,000 cfm. and pressures up to 20 pounds. An oil sealing arrangement in the blower prevents air contamination. A symmetrical epicycloidal rotor acts as an air screw taking in the air and discharging it from pockets which form between the rotors. "Compression is gradual and free from

GASOLINE FROM COAL

Through

B&W TUBES

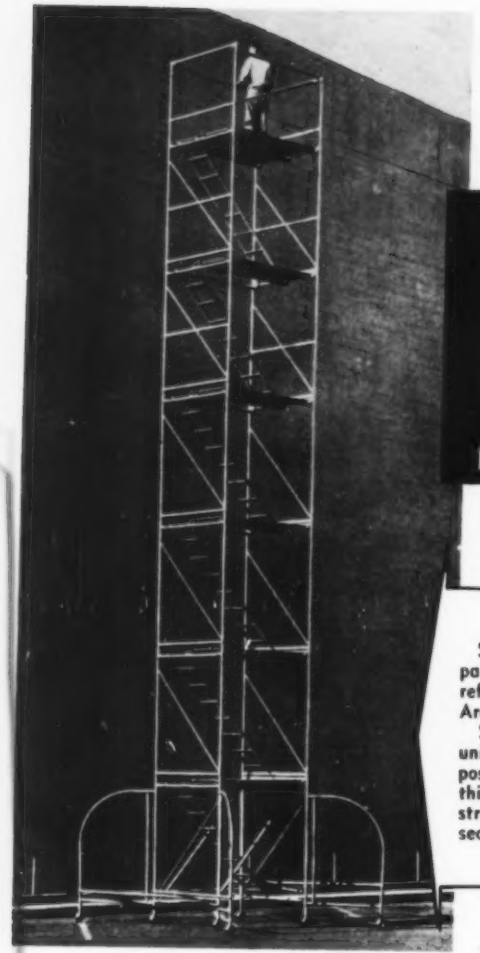
These five different types of B&W Tubing were selected for various vital services in the nation's first coal hydrogenation plant. At the U. S. Bureau of Mines' Coal-to-Oil Demonstration Plant at Louisiana, Missouri, B&W Tubing is in operation at various temperatures up to 1000° F. and at pressures up to 10,000 p.s.i., helping to produce 200-300 barrels of oil per day.

Use of these five steels indicates how completely B&W Seamless and Welded Tubing cover the range of requirements for carbon, alloy, and stainless analyses for economically solving any heat, pressure, corrosion, or oxidation problem in all petroleum or chemical conversion processes.

B&W SEAMLESS and WELDED TUBES

TA-1495-S

THE BABCOCK & WILCOX TUBE COMPANY GENERAL OFFICES: BEAVER FALLS, PA. PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO



"75% SAVED ON OVERHEAD REFINERY MAINTENANCE"

Reports Superintendent G——

with Revolutionary, new . . .

ALUMINUM ALLOY

UP-RIGHT SCAFFOLDS

AND

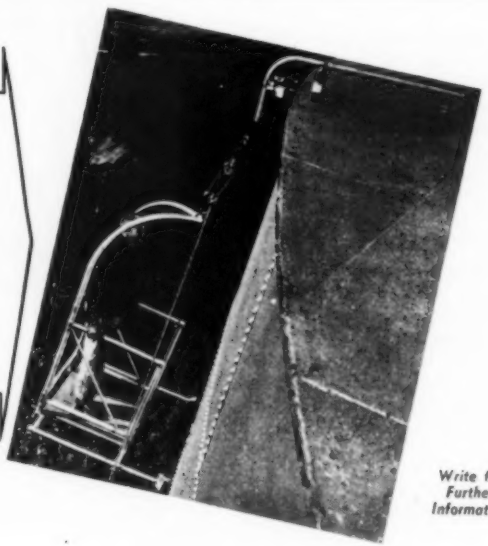
ROLL-AROUND SAFETY CAGE

Mobile 45′ unit takes only 15 minutes to erect!

Scores of refinery users report big labor savings on tank painting, cleaning, inspection, repairing and general overhead refinery maintenance with Up-Right Scaffolds and Roll-Around Safety Cage.

Scaffolds are available in desired number of 6-foot section units for rapid, easy assembly. Roll easily from position to position throughout job. Stronger than structural steel yet one third the weight. Safety tread stairway completely within structure. No wrenches, wing nuts, bolts, loose parts. Each section folds flat.

Roll-Around Safety Cage, anchored to eye-bolt on top of tank, provides a new, faster method for covering entire wall areas of tanks. Weighs only 95 lbs., and its unique design permits the use of pole guns and bulky maintenance equipment. Unusual safety features include widely spaced legs which eliminate wind hazards.



UP-RIGHT SCAFFOLDS

Dept. 125 • 1013 PARDEE STREET • BERKELEY, CALIF.

Factories: Berkeley, Calif. and Teterboro, N. J.

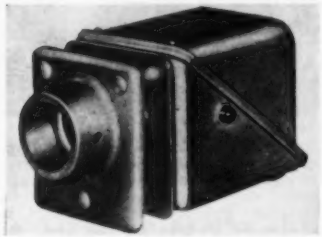
Sales Offices in All Principal Cities

Write for Further Information

shock." Blowers which are tested in accordance with ASME standards will pull a vacuum or deliver a positive pressure.

For further information write The Standard Stoker Company, Inc., Stoker Division Works, Erie, Pa., referring by number to this PETROLEUM REFINER item.

Flame Safeguard (Item 417)



For flame failure protection of commercial and industrial oil burning equipment, Combustion Control Corporation has introduced type F18T-2 in Bulletin CA496. A phototube and amplifying system are housed in a compact, rugged, dust-tight aluminum case. Heat-resisting filters and heat insulating fins and spacers serve to thermally insulate the housing from high boiler wall temperatures so that the entire control may be mounted directly on the furnace wall. Other features include an hermetically sealed time delay element which prevents the relay from dropping out from purely transit flame disturbances; a pilot light indicating flame failure can be viewed through an angle of 180; and a cover switch to prevent unsafe operation of the control should the cover be removed.

For a copy write Combustion Control Corporation, 77 Broadway, Cambridge 42, Mass., referring by number to this PETROLEUM REFINER item.

Vertical Turbine Pumps (Item 418)

Vertical turbine oil lubricated pumps in sizes six to 14 inches in Bulletin H-450-B35; rotary pumps employing a mechanical seal and self lubricating inboard sleeve in Bulletin W-484-B-1; and self-priming centrifugal all-steel pumps in Bulletin W-395-B1 are presented by Worthington Pump and Machinery Corporation. Specifications, pictures, diagrams and dimensions are given for each of the pump models.

For copies write Worthington Pump and Machinery Corporation, Harrison, N. J., referring by number to this PETROLEUM REFINER item.

Protective Coatings (Item 419)

United Chromium, Inc.'s bulletin on Ucilon protective coatings identifies each coating and its proper application. It also points out how as a component in a "system" of coatings, each particular coating creates greater corrosion resistance and lasts longer. Case histories are presented to show that specialized coating systems have provided the answer to many corrosion problems.

For a copy write United Chromium, Inc., 51 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

Dial Gage (Item 420)

Helicoid Gage Division of American Chain & Cable Company, Inc., has developed a 3½-inch dial gage made with a steel Bourdon tube for use in ammonia ice machines, pumps, compressors and hydraulic presses up to 10,000 psi. Feature of the new gage is the Helicoid movement, which the manufacturer claims has no teeth to wear out. The gage has stainless steel bourdon tubes, fused joints and an external pointer adjuster. It is supplied in 4¼ inches, 6 and 8½-inch dial sizes.

For further information write Helicoid Gage Division, American Chain & Cable Company, Inc., Bridgeport 2, Conn., referring by number to this PETROLEUM REFINER item.

Heat Transfer Fluids (Item 421)

Heat transfer fluids with resistance to sludging and coking have been presented by Carbide and Carbon Chemicals Corporation. Made from polyalkylene glycols and derivatives, the synthetic fluids differ chemically and in performance characteristics from petroleum oils, silicones and synthetic oils developed by Germany during the war. Both water-soluble and water-insoluble fluids are available. A water-soluble heat transfer medium, "50-HB-280-X," has a viscosity of 280 Saybolt Universal seconds at 100° F. A water-insoluble medium, LB-300-X, has a viscosity of 300 at 100° F.

For further information write Carbide and Carbon Chemicals Corporation, 30 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

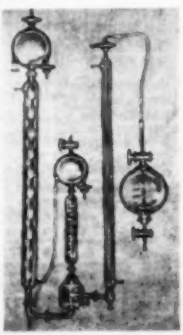
Acid-Proof Brick (Item 422)

Laclede-Christy Company has announced the addition of the following products: silica brick, acid-proof brick and Ohio fire brick. These products "enable the company to supply complete lines of refractories."

For further information write Laclede-Christy Company, Ambassador Building St. Louis 1, Mo., referring by number to this PETROLEUM REFINER item.

Flash Evaporator (Item 423)

A glass flash evaporator designed for laboratory use and an improved othmer still are offered by Emil Greiner Company. Experimentally verified, the evaporator operates under reduced pressure to lower the temperature of evaporation. The time of contact at evaporation temperatures is short, reducing decomposition of heat levels. for determination of vapor-liquid equilibrium, the othmer still can be applied in chemical engineering research concerning distillation and related operations. Operation is based on the reflex equilibrium principle. Vapors are condensed into a distillate trap and the overflow from the trap is refluxed to the boiler. After equilibrium is established, and the boiling point remains constant under the total pressure imposed on the systems, samples of the liquids in the boiler are removed for chemical analysis to determine the compositions of the respective liquid and vapor phases in equilibrium.



For further information write Emil Greiner Company, 20-36 North Moore Street, New York 13, referring by number to this PETROLEUM REFINER item.

New Equipment

Pipe Threading Machine (Item 424)

With a 3-hp., 220-volts 3-phase 50-60 cycle motor, the "Thred-O-Matic" pipe threading machine of Quijada Tool Company has a thread-length gage of 44 inches and roller type cutter assemblies ranging from one-half to four inches. Four interchangeable high speed dies are supplied per head. Spindle speeds of 17.5 rmp. to 118 rpm. and an automatic chucking feature of four front jaws and four rear jaws are other features. Maximum carriage travel is 16 to ½ inch. Also included are flat bladed type reamers with one attached to each die head; transmission provided by spur gears mounted on shafts held in place by double shielded ball bearings; chip pan with perforated metal bottom for drainage; and oil pump and cups.

For further information write Quijada Tool Company, Los Angeles, referring by number to this PETROLEUM REFINER item.

Bottle Washer (Item 425)

The new bottle washer of Ogden Filter Company will accommodate bottles of all sizes up to one gallon, operating equally well in cleaning narrow or wide mouthed containers. The bottles are placed on the arms of the washer, which have self-adjusting spring steel wire holders. The operator handles only the unwashed and the clean, dry bottles. A water soluble detergent solution is used for cleaning the bottles. Features claimed for the instrument include inspection doors located at intervals, a variable speed control, vents which remove fumes, moisture and vapor, divided sections with separate drains, a detergent solution maintained at 140° and which can be reused, high jet pressure and sterile bottles.

For further information write Ogden

New Equipment

Filter Company, 2414 Santa Monica Boulevard, Los Angeles, referring by number to this PETROLEUM REFINER item.

Flow Blower (Item 426)

L. J. Wing Manufacturing Company offers a forced-draft blower incorporating a combined electric motor and steam turbine drive. Basic unit is the "R" turbine blower with a totally enclosed, dust-proof motor connected to an extention of the turbine shaft. Throttling gives speed control of the turbine, and voltrol vanes permit capacity regulation for the motor drive. Automatic operation of both drives may be arranged in connection with a combustion control system. A vertical unit may be adapted to horizontal discharge by adding supporting feet.

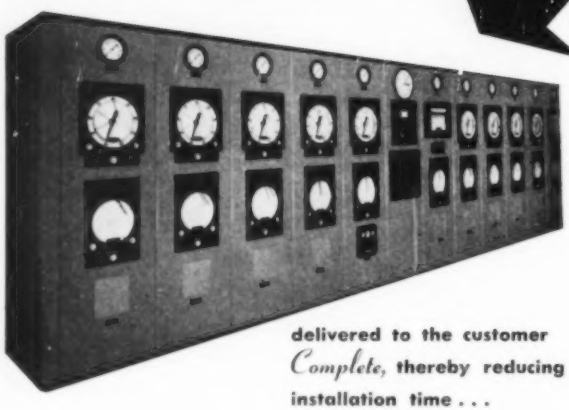
For further information write L. J. Wing Manufacturing Company, New York, referring by number to this PETROLEUM REFINER item.

Steam Specialties (Item 427)

Strong, Carlisle & Hammond Company's steam specialties Catalog 68A gives specifications and recommendations for use of its line of traps, strainers, reducing valves and separators. Selection, sizing and maintenance of Strong's steam traps is also presented.

For a copy write Strong, Carlisle & Hammond Company, 1392 West Third Street, Cleveland 13, Ohio, referring by number to this PETROLEUM REFINER item.

12 PANEL INSTRUMENT CUBICLE for natural gasoline plant



delivered to the customer *Complete,* thereby reducing installation time . . .

The Instrument Cubicle, shown above, was recently built by Nelson Electric Manufacturing Company for use in a natural gasoline plant.

All construction details—including fabrication, assembly, the mounting, piping and wiring of instruments—were performed in our factory as a service to the customer.

This 12-panel unit is 25 feet long, 40 inches deep and 88 inches high. Enclosed with access doors at each end, the cubicle is made self-supporting by means of a channel framework base and top.

Instruments are mounted on formed sheet steel panels. Explosion-proof construction is used throughout.

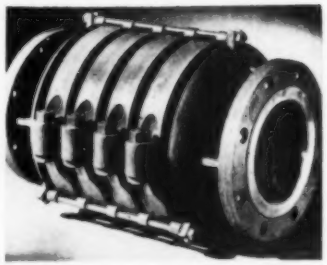
Rounded corners and the symmetrical arrangement of instruments contribute to the excellent appearance of this unit. These cubicles are available in all sizes and types of construction.

NELSON *Electric* MANUFACTURING CO.

217 North Detroit TULSA, OKLAHOMA Telephone 2-5131

Manufacturers of: Explosion Proof Motor Controls, Junction Boxes and Enclosures, Circuit Breakers and Lighting Panels, Oil Field Motor Controls, Automatic Pipe Line Sampling Devices, Cathodic Protection Equipment, Switchboards, Instrument and Control Panels, Unit Substations.

Packless Joint (Item 428)



Adsco "Corruflex" expansion joint, requiring no packing, has been manufactured by American District Steam Company, for use in remote locations, trenches, and tunnels. Described in Folder No. R-149, the traverse of the joint ranges from fractions of an inch to 15 inches operating under pressures from vacuum to 300 pounds and temperatures from sub-zero to 1600° F. Available in sizes from 3 to 24 inches, single or multiple corrugation, with or without self-equalizing rings, single or double units, and with either flanged or welding ends, it is supplied in copper, stainless steel or their alloys and with internal sleeves if required.

For a copy write American District Steam Company, North Tonawanda, N. Y., referring by number to this PETROLEUM REFINER item.

Fire Hose (Item 429)

United States Rubber Company has developed a high-strength fire hose for resistance to acids and acid fumes, oil and gasoline. Under the trade name, "Matchless Carbolized Fire Hose," it is designed primarily for fire protection and general wash down service in acid plants and oil refineries. The hose is constructed with a natural rubber tube, two plies of chemically treated cotton cord fabric and a neoprene cover 5/64-inch thick to resist 400 psi. test pressure.

For further information write Public Relations Department, United States Rubber Company, Rockefeller Center, New York 20, referring by number to this PETROLEUM REFINER item.

Glass Heat Panels (Item 430)

Electriglas radiant heat panels, introduced by Appleman Glass Works, produce heat by a metallic alloy grid, fused into curved Temprex glass. Current passing through the grid generates infra-red heat. The panels can be connected with conduit or cable to present AC or DC 110 volt or 220 volt circuits and are installed flush with the wall. The heating element is guaranteed for life by the manufacturer.

For further information write Appleman Glass Works, Bergenfield, N. J., referring by number to this PETROLEUM REFINER item.

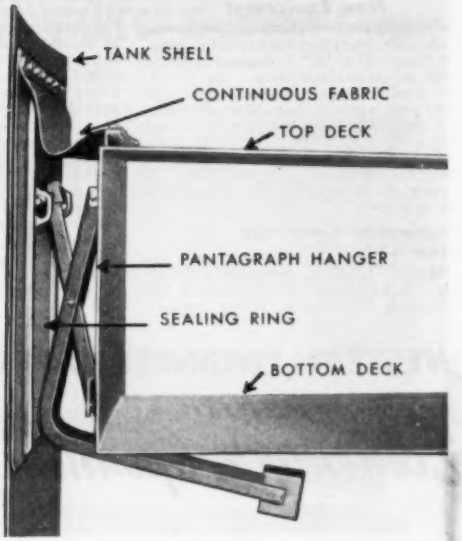
Saran-Rubber Lined (Item 431)

Saran rubber 187, presented by The Dow Chemical Company, is resistant to abrasion and excells as an inert lining material when in contact with petroleum products, chlorinated hydrocarbons, bleaching agents, general acids and other chemical mixtures. Lining is ⅛-inch

These Improved Features increase the efficiency

of

HORTON Double-Deck Floating Roofs



To effectively protect the contents of your tanks against evaporation losses, several improved features are now standard construction on Horton Double-Deck Floating Roofs. You get this kind of protection because these features make the Improved Horton Seal the most efficient device ever developed for preventing the escape of vapors around the edge of a floating roof.

The view at the upper right of a full size cross section of a Horton Seal shows how it functions. The continuous fabric closes the space between the deck and the sealing ring. Pantagraph hangers inside the seal hold the sealing ring surely but gently against the tank shell so that it maintains a long sliding contact as the roof travels up and down in the tank. The vertical flexures spaced at twenty-two inch intervals in the sealing ring allow it to conform to irregularities in the tank shell.

Protection against costly evaporation losses isn't all that you get from these improved seal features. In addition, the top deck of a Horton Double-Deck Floating Roof is entirely free of sealing devices—such as hangers, braces, secondary seals and the like—for with this design all the mechanism is *inside* the seal. For complete details, write our nearest office for a copy of Bulletin B.

The view at the left shows a 16,800-bbl. tank equipped with a Horton Double-Deck Floating Roof for the Socony-Vacuum Oil Company, at Harrisburg, Pennsylvania.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafayette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Salt Lake City 1	1531 First Security Bank Building
Boston 10	1030—201 Devonshire Street	Houston 2	2126 National Standard Building	San Francisco 11	1251—22 Battery Street Building
Chicago 4	2463 McCormick Building	Los Angeles 14	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Guildhall Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

REPRESENTATIVES AND LICENSEES

Ateliers et Chantiers de la Seine Maritime, Paris, France
Compagnia Tecnia Industrie Petroli, S.A.I., Rome, Italy
Constructions Metalliques de Provence, Aries-sur-Rhone, France
Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Whessoe, Limited, Darlington, England
Chicago Bridge & Iron Company, Ltd., Apartado 1348 Caracas, Venezuela

thick with operating temperatures ranging from —5° to 167° F. dependent somewhat on service conditions. The Michigan Pipe Company produces steel pipe lined with saran rubber 187 in all standard sizes from eight inches to 36 inches inclusive.

For further information write The Dow Chemical Company, Midland, Mich., referring by number to this PETROLEUM REFINER item.

Preparative Centrifuge (Item 432)

Model L Spinco preparative centrifuge, manufactured by Specialized Instruments Corporation, is the vacuum-chamber type with a two-stage mechanical pump. Electronic control, speed control, braking and a shutdown device are all automatic. Rotors 6¾ inches in diameter hold 150 cc. of material and make 40,000 rpm. The 11-inch (diameter) rotor holds a liter and makes 20,000 rpm. The manufacturer claims the speed is limited to safe operation for each size. The unit will not operate unless the rotor chamber is properly evacuated, the vacuum chamber will not open during the operation and a warning light flashes when the oil supply is low. Refrigeration facilities are also available.

For further information write Specialized Instruments Corporation, 648 O'Neill Avenue, Belmont, Calif., referring by number to this PETROLEUM REFINER item.

WESTERN ENGINEERED PRODUCTS
FURNISH
Economy in Operation
SKELLY

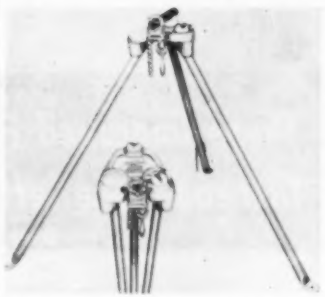
at.... SKELLY OIL COMPANY
VELMA, OKLAHOMA, NATURAL GASOLINE PLANT

Dependable heat transfer equipment from Western's precision-tooled manufacturing facilities contribute to the unique operation of Skelly's Velma plant, designed and constructed by Born Engineering Company of Tulsa in collaboration with Skelly's Natural Gasoline Department. Such Western equipment, carefully executed from exacting specifications, is to be found in gasoline plants, refineries, chemical processing plants and pipelines throughout America.

WESTERN
HEAT EXCHANGERS
Manufactured by
WESTERN SUPPLY COMPANY
P.O. BOX 1088 TULSA, OKLAHOMA
SALES OFFICES — DALLAS — HOUSTON

See Western's catalog pages in the current issues of Chemical Engineering Catalog, Refinery Catalog, and Thomas Register.

Aluminum Vise Stand (Item 433)



An aluminum vise stand of J. H. Williams and Company, having the advantages of rigidity and strength, "with weight reduced nearly 50 percent of that found in heavier iron or steel types," is described in Booklet No. A-70. The base is made from special aluminum alloy which has high tensile and high impact properties. Two pipe benders are provided, one for pipe up to ½ inch, the other for pipe up to ¾ inch. Recess for oil can and handy slots for tools are provided in addition to the "V" pipe support. Aluminum alloy legs may be folded and tied together with permanently attached chain.

For a copy write J. H. Williams & Company, 400 Vulcan Street, Buffalo 7, N. Y., referring by number to this PETROLEUM REFINER item.

Gage Illuminators (Item 434)

Gage illuminators of Jerguson Gage & Valve Company, incorporate the principle of solid-wedge lighting in combination with plastic, whereby the illumination from a single light source is reflected from an angular surface and flows with evenly diffused intensity through the transparent gage glass. The explosion-proof light unit is built in accordance with Underwriters' Laboratories standard for electric lighting fixtures for use in hazardous locations for Class 1, Group D services. Fitting is entirely separate from the plastic wedge and consists of an aluminum housing for the wiring and bulb socket and a thick heat-resisting glass housing for the light bulb.

For further information write Jerguson Gage & Valve Company, 87 Fellsway, Somerville, 45, Mass., referring by number to this PETROLEUM REFINER item.

Multi-Switch Capacitrol (Item 435)

An indicating pyrometer controller, the multi-switch capacitrol, is explained in Bulletin MC-1 of Wheelco Instruments Company. Suggested applications, measuring and indicating features, control functions, method of applying the electronic principle, scale ranges and technical data are included.

For a copy write Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, referring by number to this PETROLEUM REFINER item.

Capacitrols, Panels (Item 436)

Bulletin PC-1 describing the "Panelmount" capacitrol series of indicating pyrometer controllers, and Bulletin PI-1

NOW IT'S HERE...*the New "VAREC" Electronic Gauger!*

COSTS YOU LESS

Initial costs are lower because the new electronic design eliminates Selsyn Motors. Installation costs are less because fewer and smaller wires are used.

GIVES YOU GREATER ACCURACY

Accuracy is only limited by types of float gauge used. Measures liquid level to ± 1/16" with "VAREC" 253 Series Automatic Tank Gauges. Not affected by wide line voltage variations.

PROMOTES SAFETY

No climbing on slippery tanks during wet or icy weather. No danger from toxic vapors. Low voltage, low current transmitter completely isolated from tank vapors.

EASY TO OPERATE AND MAINTAIN

You need only select the tank to obtain an accurate continuous gauge reading. You need only push a button to instantaneously check receiver adjustments. It is not necessary to reset instrument after power failure.

GREATER VERSATILITY

Transmitters may be installed on tanks already equipped with suitable float-type gauges. Small, compact receiver may be located on desk or panel mounted. Readings may be made at more than one remote position by installing additional receivers. High-low level alarms or controls may be added to the receiver without running additional wires to the tanks.

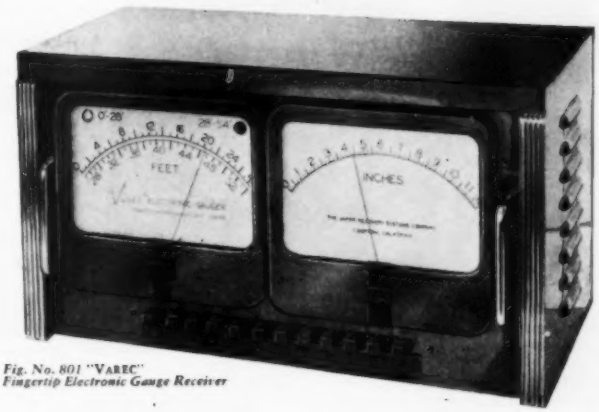


Fig. No. 801 "VAREC" Fingertip Electronic Gauge Receiver

REMOTE LIQUID LEVEL GAUGING AT ITS BEST!

Now you can gauge your tanks accurately to within ± 1/16" of tank level on a centrally located panel. The new "VAREC" Electronic Gauges enable you to duplicate tank gauge readings at any location... gives you greater accuracy when installed with "VAREC" Automatic Tank Gauges. Eliminates traveling throughout the tank farm or gauging tanks outside during bad weather. Eliminates the dangers of toxic vapors. Eliminates the errors from the human element in gauging.

MULTIPLE OR SINGLE TANK RECEIVERS

Multiple Tank Receivers, for individual gauging up to 10 tanks or up to 24 tanks; On-Gauge Receivers for individual tanks or simultaneous gauging. The front panel of each receiver has two dials. Feet indications from 0 to 54 feet are read on the left-hand dial and inch indications from 0 to 12 inches by 1/8" increments are read on the right-hand dial. Proper reading of the foot scale is designated by two colored pilot lights at the upper corners of the dial. The receivers are designed for use on 110-115 volt, 50-60 cycle, a-c power.

EXPLOSION-PROOF TRANSMITTERS

Transmitters are available in four designs to meet tank working pressure requirements. All are designed to be explosion-proof, suitable for use in Class 1, Group D, hazardous locations.

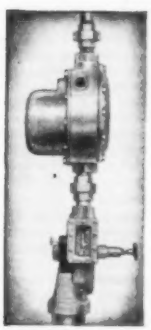


Fig. No. 850 Electronic Gauger Transmitter installed above lookbox of "VAREC" Fig. No. 253 Automatic Tank Gauge.

PROVED and APPROVED

"Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY

NEW YORK PITTSBURGH CHICAGO TULSA HOUSTON

COMPTON, CALIFORNIA, U.S.A.

DEPT: PR

NAME_____ TITLE_____

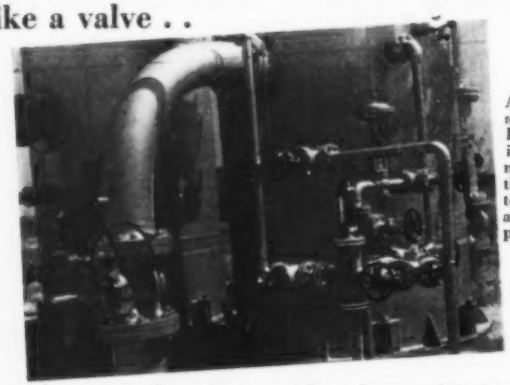
STREET and No._____

CITY and STATE_____

Send for Your Copy of "Remote Gauging at Its Best" Today!

SEE THE "VAREC" ELECTRONIC GAUGER AT THE I.S.A. INSTRUMENT EXHIBIT IN ST. LOUIS SEPTEMBER 12-16

This flow meter "takes to" your pipe system like a valve . .



A typical installation of FLOWRATOR instruments metering Diethylene Glycol to absorbers in a gas treating plant.

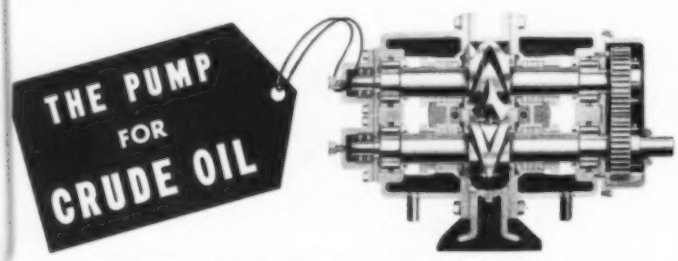
More and more outstanding refineries are taking advantage of the "in-a-line" installation simplicity of the FLOWRATOR (formerly Rotameter) rate of flow instrument.

You get these advantages:
- Uniform scale (no square root)
- A single moving part
- Long flow range (15 to 1)
- Low constant pressure drop
- Handle high temp. & press., corrosive & viscous flows

And none of these disadvantages:
- No external piping
- No seal pots
- No equalizing valves
- No purges
- No clogging

WRITE FOR CATALOGS 10 AND 40

FLOWRATOR TRADE MARK • **FISCHER & PORTER CO.**
DEPT. 9T-1C HATBORO, PA.



KINNEY HQA ROTARY PUMPS thrive on crude oil. Steep three-tooth helical rotors are specially designed to work fast, to eliminate trapping, and to give long years of dependable service. Maximum protection against wear is an important feature of HQA Pumps. Hardened and ground timing gears and anti-friction radial and thrust bearings — located outside the pumping chamber and independently lubricated — maintain fixed rotor clearances within the pump cylinder. Pumps with renewable head liners are available to meet special conditions. Furnished either plain or steam jacketed. Write for Bulletin L48 — address Kinney Mfg. Co., 3596 Washington St., Boston 30, Mass. Branches in New York, Chicago, Cleveland, Philadelphia, Los Angeles, San Francisco, Seattle, New Orleans, Houston.

MAX. THEORETICAL DISPLACEMENT U.S. GPM VS. VISCOSITY

PUMP SIZE	Press. Rating, lbs.	at 22,500 SSU	at 45,000 SSU	at 67,500 SSU
HQA 103-31S	300	478	387	337
HQA 1226-31	300	597	482	432
HQA 167-31	275	1036	818	720

Other sizes for lower pressures are also available.

We also manufacture Vacuum Pumps, Clutches and Bituminous Distributors

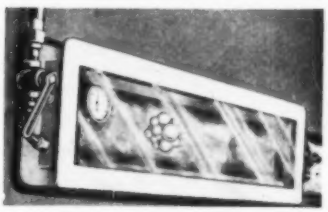
KINNEY *Rotary* PUMPS

New Equipment

describing cabinet type instrument panels are offered by Wheelco Instruments Company. The capacitrol features drawer type chassis, complete front accessibility, the Wheelco electronic principle, pilot light ignition and interchangeable unit construction. The capacitrols are contained in a horizontal case, 6¾ inches high permitting the mounting of multiple units on one instrument panel. The instrument panels, for mounting instruments and auxiliary equipment, can be used to mount units in a minimum overall space of 24 inches wide by 72 inches high by 12 inches deep.

For copies write Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, referring by number to this PETROLEUM REFINER item.

Vacuum Seam Tester (Item 437)



A device for quickly locating leaks in the construction of pipes, tanks or other storage vessels is the patented American vacuum seam tester manufactured by American Pipe & Steel Corporation. This compact, portable unit, which can test old equipment while in service, operates on a vacuum principle. The instrument's seams are covered with soap suds, are overlaid with an inspection box having a clear glass top and soft rubber base. The vacuum created within the inspection box draws air through any leaks causing soap bubbles to form. Testers are available for inside and outside corners, circumferential seams and straight seams. They help locate leaks caused by refinery chemicals rust-enlarged by moisture seepage, etc.

For further information write American Pipe & Steel Corporation, 2201 West Commonwealth Avenue, Alhambra, Calif., referring by number to this PETROLEUM REFINER item.

Gas Welding Supplies (Item 438)

Description of the mechanical properties of various gas welding supplies and recommendations regarding their applications are presented in the new catalog of Air Reduction Sales Company. Gas welding rods, fluxes, silver brazing alloys, carbon rods and carbon plates are included. Data on lengths, packaging and availability are given for each welding rod.

For a copy of the catalog write Air Reduction Sales Company, 60 East 42nd Street, New York 17, referring by number to this PETROLEUM REFINER item.

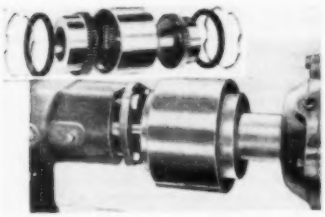
High Vacuum Apparatus (Item 439)

Central Scientific Company's booklet on its high-vacuum apparatus, includes suggestions for planning a high-vacuum system; information on pumping speed;

explanation of merit factor, connections and speed of evacuation, low pressure technique, and other data, together with a complete listing of Cenco mechanical pumps, D-P diffusion pumps and Cenco gages, oils, traps and other vacuum accessories.

For a copy write Central Scientific Company, 1700 Irving Park Road, Chicago 13, referring by number to this PETROLEUM REFINER item.

Gear Coupling (Item 440)



A gear coupling which uses seven parts and has no bolts, developed by Sier-Bath Gear & Pump Company, is made of forged high carbon steel with internal teeth running the full working length and is available in sizes of ¾, 1, 1¼, 2, and 2½ inches. A Neoprene seal keeps oil from leaking out and dirt from entering. It is reinforced with a garter spring and has resiliency to maintain constant closure against slight depressions and unevenness of the shaft surfaces. The hub teeth are cut radially, permitting perfect alignment without excessive backlash in the teeth.

For further information write Sier-Bath Gear & Pump Company, Inc., North Bergne, N. J., referring by number to this PETROLEUM REFINER item.

Water Gauge (Item 441)

Models, list prices, dimensions and methods of installation of Penberthy Injector Company's liquid level and water gauges are discussed in Catalog 35. Advantages of flat glass (reflex and transparent) and tubular glass gauges are explained along with suggestions on how to reduce glass breakage. Pressure-temperature ratings are given for all gauges, as are the specifications and properties of the materials used. Special gauges are included for uses requiring 10,000-psi. service pressure at temperatures up to 250° F.

For a copy write Penberthy Injector Company, 1242 Holden Avenue, Detroit 2, referring by number to this PETROLEUM REFINER item.

Valimitor Motor Starters (Item 442)

Protection against short circuits, overloads and low voltages are claimed for the Valimitor motor starters of The Electric Controller and Manufacturing Company in Volume 1, No. 23, of the EC&M Accelerator. Suitable for use with 2300-4600 volt motors on a power circuit of any capacity, the starters have the added advantages of "cushioned starting and not requiring replacements to restart after a fault."

For a copy of the bulletin write The Electric Controller and Manufacturing Company, 2700 East 79th Street, Cleveland 4, Ohio, referring by number to this PETROLEUM REFINER item.

Construction Materials (Item 443)

Materials of construction and packing materials for use with over 300 industrial liquids and gases are listed in Catalog section 97 of Fischer & Porter Company. This tabulation of corrosion-resistant materials lists materials for Flowrator instruments giving fluids, fittings, float and packing and also gives notes on metals to use in cast form.

For a copy write Fischer & Porter Company, 97 County Line Road, Hatboro, Pa., referring by number to this PETROLEUM REFINER item.

Angle Valves (Item 444)

Circular 101 of The Kennedy Valve Manufacturing Company describes bronze globe and angle valves with renewable composition discs recommended for services up to 150 pounds steam or 300 pounds cold water, oil, air or gas. The valves have beveled shoulders making tight joint with conical seat on underside of bonnet when valve is wide open, for repacking under pressure. A sectional drawing gives visual reference and explanation of the complete valve. A table of available sizes and dimensions is also included.

For a copy write The Kennedy Valve Manufacturing Company, Elmira, N. Y., referring by number to this PETROLEUM REFINER item.

ANOTHER REASON WHY

Badger

IS FIRST IN

expansion joints

Because the flexing member is made from a single tube, Badger Expansion Joints are installed without packings. This feature alone means valuable savings in man hours . . . assures long service without attention.

And that's only *one* reason why you get top performance — *at lowest cost* — from Badger Corrugated Expansion Joints. Here are others:

- Flexible . . . joints easily compress and expand reducing thrust on adjacent fittings and equipment
- Compact . . . require no more space than regular flanged fittings
- Special forming methods . . . no danger of structure-weakening stresses
- Controlled heat treating . . . to assure long life for flexing member
- Directed flexing rings . . . to equalize stresses *between* and *within* corrugations

These features are important in any pipe line job — you can get them *all* only by specifying Badger Expansion Joints.

Write today for Bulletin 100 (self-equalizing type) or Bulletin 200 (non-equalizing type).

Badger MANUFACTURING COMPANY
260 BENT ST. CAMBRIDGE 41, MASS.

About EQUIPMENT and SERVICE Suppliers

Rockwell Names Executive

Wm. A. Marsteller, Chicago, and Robert P. Melius, Milwaukee, have been elected vice presidents of Rockwell Manufacturing Company, Pittsburgh.

Marsteller

Melius was recently placed in charge of sales for the newly-created power tool division of Rockwell Manufacturing Company which will market Delta, Crescent, Multiplex and Delta-Homecraft wood and metal working tools. He has been with the Delta manufacturing division for 19 years, and has been sales manager of that division since 1935.

Marsteller for the past several years has been manager of advertising and market research for the company, as well as vice president of Edward Valves, Inc., East Chicago, Ind. He is completing a two-year term as president of the National Industrial Advertisers Association, and is a director of the University of Illinois Alumni Association. He is also a member of the American Marketing Association, the Association of National Advertisers and the American Statistical Association.

Whessoe of England to Make Shand and Jurs Products

Shand and Jurs Company of Berkeley, Calif., has completed license arrangements with Whessoe, Limited, of Darlington, England, for the manufacture of S&J products in that country. Whessoe, Limited, was founded in 1790 and is one of the largest manufacturers of storage tanks and other petroleum and chemical industry vessels outside of the United States.

The addition of the Shand and Jurs line of specially designed valves, gauges, and other safety and conservation equipment used with such tanks and vessels will complement their activity in that field.

Green Fire Brick Elects Executive Vice President

A. P. Green Fire Brick Company's board of directors has elected William S. Lowe of Winsted, Conn., executive vice president.

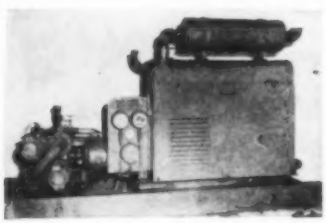
Lowe came to Green from the Reeves-Ely Laboratories, Inc., New York, with which he has been associated since 1944 and in connection with which he has served as chairman of board and president of Winsted Hardware Manufacturing Company; chairman of executive committee, director and treasurer of American Transformer Company, and vice president of Waring Products Corporation. A native of Kansas and a graduate of South Dakota State College with a degree in electrical engineering he was formerly division superintendent with General Electric Company. Two years during the war he was an executive of SKF Industries, Incorporated, Philadelphia.

General American Planning Railroad Fair Car Exhibit

General American Transportation Corporation will be represtened at the Chicago Railroad Fair this year by a two-fold exhibit of an all-welded aluminum tank car and the latest development of refrigerator car for transporting frozen foods. Inside the refrigerator car an exhibit is to show the operations of the company. Models of cars, photographs and actual products will also be displayed along with liquid storage terminals, bus building activities, plastics molding operations and the fabrication of heavy equipment used in the refinery

Byron-Jackson "P.U.P." 2-Stage PUMPING UNITS

for gasoline — crude — water



$1,250 each
F.O.B. Houston, Texas
Subject to prior sale

•

Complete with Electric Starter, Generator, Battery, Etc.

•

Ideal for salt water disposal wells

•

EXCELLENT FIRE PUMPS

This unit consists of one 3-inch 2-stage Byron-Jackson "PUP" Pickup Centrifugal Pump—3 inch suction and discharge, 4 inch adapters for couplings, 200 BPH @ 680-feet head or in parallel 400 BPH @ 340-feet head, direct connected to Chrysler Model C-36 (Ind-9) Industrial 8-Cylinder Engine, skid mounted, spare parts and tools. Wt. 4060 lbs. Skid length 9 feet 6 inches, Height 62 inches, Width 29 inches.

SURPLUS - NEW - CRATED FOR EXPORT with parts and tools

HALLORAN Equipment Co.

431 Kress Bldg. HOUSTON 2, TEXAS Phone CA pitol 1447

Simple Cleaning Method Cuts Equipment Down-Time 50%!

THAT'S what a Texas operator discovered when he installed a specially engineered Oakite method of cleaning complete processing system—absorber, heat exchanger, still, pre-heater. Circulation of a recommended Oakite cleaner, under carefully determined temperatures and pressures, resulted in quick break-up of carbonized deposits, grease films, basic sediment.

If you are interested in less shutdown time and higher output at closer specifications . . . call the Oakite Technical Service Representative near you. Or write for your free copy of the Oakite Petroleum Digest of 88 maintenance cleaning and descaling procedures. Oakite Products, Inc., 50B Thames St., New York 6, N. Y.

Technical Service Representatives Located in Principal Cities of United States and Canada

OAKITE

REG. U. S. PAT. OFF.

SPECIALIZED INDUSTRIAL CLEANING

MATERIALS • METHODS • SERVICE

and process industries. Other features will be the company's building activities and the design and building of Wiggins floating roofs, gas-holders and other structures for the conservation of valuable, volatile vapors.

Borg-Warner's Pesco Announces Staff Change

Pesco Products Division of Borg-Warner Corporation has appointed John A. Lauck vice president, D. A. Sutherland industrial relations manager, and Frank R. Canney sales engineer in charge of the company's sales activities with the air line companies.

Lauck, former chief engineer of the company's pump division for the last four years, has been associated with the company since 1937 as test engineer, chief test engineer and assistant chief engineer. He has helped develop the company's line of fuel, vacuum and hydraulic pumps for aircraft and a new series of "pressure loaded" hydraulic pumps for industrial use.

Sutherland, formerly eastern sales manager for Industrial Producers, has served as field engineer in charge of sales and sales promotion for the B-W supercharger division of Borg-Warner and earlier was power engineer and sales engineer for Fairbanks-Morse and Company. G. V. Patrick, formerly executive vice president of Cleveland Automatic Machine Company, will succeed him.

Canney was formerly employed for 25 years with Boeing Airplane Company.

Manning, Maxwell, Moore Names Valve Sales Manager

C. F. ("Cy") Johnson, who has been associated with Manning, Maxwell and Moore, Inc., Bridgeport, Conn., for the past year has been appointed manager of valve sales of the company. A graduate of Rice Institute, Johnson's business career has included the positions of product research, district engineer and division engineer for the Reed Roller Bit Company of Houston, Texas, sales and management responsibilities with the Security Engineering Company, Whittier, Calif., and chief engineer of the distributor products division of Watson-Stillman Company of Roselle, N. J. Johnson will be in charge of all valve sales activities including Hancock valves and consolidated safety and relief valves. His headquarters will be in Bridgeport, Conn.

Johnson

New Assistant Sales Manager

Grant E. Scott, Jr., has been named assistant sales manager of Klipfel Valves, Inc., a division of Hamilton-Thomas Corporation, Hamilton, Ohio. Scott will serve as assistant to Frank Breor, sales manager of the division.

A graduate of Phillips Exeter Academy and Princeton University, Scott was previously associated with Wright Aeronautical Corp. as test engineer, and with Allis Chalmers Manufacturing Company as field and sales engineer.

Whiton Appoints Executives

Peterson

Beaney

The Whiton Machine Company of New London, Conn., has announced the promotion of Stanley E. Peterson to vice president and secretary and of Walter E. Beaney to vice president and factory manager.

Pennsylvania Salt Opens Fluorine Chemical Plant

Pennsylvania Salt Manufacturing Company's new fluorine chemical plant at Calvert City, Ky., now is in operation. Under construction for approximately a year, the new $2 million works will be devoted in its initial stages to the production of sulfuric acid and hydrofluoric acid and will operate 24 hours a day.

Plans call for enlargement of the plant. Its present area occupies approximately 10 acres of a 500-acre tract owned by Pennsalt and is located north of Calvert City, between Paducah and the TVA Kentucky dam at Gilbertville from which electric power is received.

Bigelow-Liptak Appoints Two Eastern Sales Agents

The Stapp Engineering Company, Tabor Building, Denver, Colo., has been selected to represent Bigelow - Liptak Corporation, Detroit, in the sale of unit-suspended walls and arches for industrial furnace enclosures in Colorado, Wyoming, New Mexico and portions of Nebraska, South Dakota and Texas.

William T. Macdonald and Kenneth Gregory, both formerly in the Detroit engineering office of Bigelow - Liptak have been appointed sales representatives. Macdonald will be located at 900 East 72nd Street, Cleveland, and will handle the northern Ohio territory. Gregory will work out of Detroit throughout Michigan, the territory handled by the late Walter F. Welsh.

Foxboro Exhibit to Keynote New Equipment Development

The development of new or improved instruments and auxiliary equipment, will be featured in the exhibit of The Foxboro Company, Foxboro, Mass., at the fourth National Instrument conference and exhibit in the St. Louis Municipal Auditorium, September 12-16.

The exhibit will include instruments and equipment first shown last year in Philadelphia such as the EMF Dynalog recording controller; the model 40 pneumatic controller; type 17 flow meter; model 42 transmitter and receiver; and the all-welded stainless steel capillary system with ⅛-inch tubing. Special display in the exhibit will be given the new strip chart dynalog recorder, an instrument suited for test work and explora-

AMMONIA

(REFRIGERATION GRADE)

DIRECT SERVICE FROM PRODUCING POINT TO USER IN

TANK CARS

and

CYLINDERS

Discuss contract shipments or spot orders with

SPENCER

SPENCER CHEMICAL COMPANY

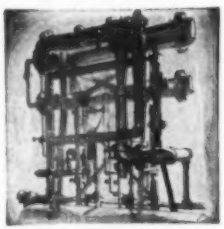
Executive & Sales Offices: Dwight Bldg., Kansas City 6, Mo.

VACUUM

99.99% PERFECT

This degree of vacuum referred to the average sea level barometer is maintained by the Croll-Reynolds five stage steam jet EVACTOR. If five stages sound complicated consider the fact that there are absolutely no moving parts. Each stage from a mechanical standpoint is as simple as the valve that turns it on. Numerous four stage units for maintaining industrial vacuum down to 0.2 mm. and less, and many thousands of one, two and three stage units are maintaining vacuum for intermediate industrial requirements on practically all types of processing equipment.

An engineering staff of many years experience has specialized on this type of equipment and has contributed toward the development of several vacuum processes which have revolutionized certain manufacturing operations, improved certain commercial products, and assisted in the development of new products.



Vacuum cooling units well known to industry as Croll-Reynolds CHILL-VACTORS and water jet ejectors round out this line of specialized equipment.

CROLL-REYNOLDS

CROLL-REYNOLDS CO.

17 JOHN STREET, NEW YORK 7, N. Y.

CHILL VACTORS STEAM JET EVACTORS CONDENSING EQUIPMENT

What's to be Said About Durability

Durability in a well water system is something that doesn't just happen.

It has to be built-in from carefully made plans, extra good materials and a lot of know how.

With nearly seventy years of experience in designing, building, testing, installing, servicing—and repairing well water systems, it seems quite logical that Layne might know something about what it takes to create durability.

Layne does! And that's a very emphatic statement backed up by actual operating facts on hundreds of systems, many of which according to their tremendous production records, should have been worn out years ago, but are still humming along at remarkably high efficiency.

Absolute perfection in any kind of mechanical equipment has never been achieved, but Layne can assure every buyer that their systems are definitely unmatched in long life durability,—a fact that probably accounts for their extraordinarily wide use.

For further information, catalogs, bulletins etc. address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

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tory operations. The electric integrator, a totalizer for use with flow meters, will also be shown. Foxboro's latest development in the field of differential pressure measurement the improved d/p cell will also be seen in operation, in conjunction with the model 40 controller and the new packless bellows-sealed valve which affords completely leak-proof control for toxic, hazardous, precious, or other fluids, or for vacuum-operated processes.

Wolverine and Hecla Open Southwestern Sales Office

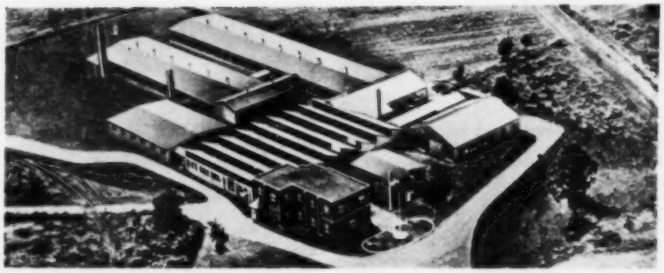
Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company have announced the opening of a new southeastern district sales office in Atlanta, Ga. A. R. Kaspark who established this office at 788 Spring Street, N. W., will cover north and central Georgia, eastern Tennessee and western counties of North and South Carolina. M. J. Cook and T. P. Stone will continue to represent the company in their western and southern sections of the southeast area.

Hooker-Detrex Appoints McKinley Works Manager

H. D. McKinley has been appointed works manager of the new degreasing-solvent manufacturing plant being erected by Hooker-Detrex, Inc., at Ashtabula, Ohio, a subsidiary of Hooker Electrochemical Company, Niagara Falls, New York, and Detrex Corporation, Detroit.

McKinley, who collaborated in the design, erection and initial operation of the company's Tacoma, Washington, plant is transferring from his position as manager of the solvents division of Detrex Corporation.

Wire Cloth Company Expands Plant



The Cambridge Wire Cloth Company has erected an additional bay at their home plant in Cambridge, Md., the 18,000 square foot addition being built to house the company's wire fabrication department. New machinery has been installed including squaring shears, bending brakes, ring and circle shears, calendaring rolls and roll forming equipment. In addition, Cambridge now has complete equipment for all types of welding, including electric arc, oxy-acetylene, heliarc and spot welding.

Ohio Steel Sales Section Transfers to Lima Office

Sales of The Ohio Steel Foundry Company's oil refinery return bends and fittings will be conducted from its Lima, Ohio, office instead of from Springfield. District offices will continue the same, however. Electric steel and alloy castings for return bend orders and Fahrite Tube Supports will continue to be made at both the Springfield and Lima foundries.

Jule D. Hagans, who has for many years managed the return bend sales at Springfield, will work with other Springfield products. Elmer H. Mollman has been named sales manager of the Fittings Division at Lima handling all equipment for the refinery industry and will be assisted by Harry H. Wright in Ohio. Both have had experience in the field of oil refinery fittings requirements.

Representatives Selected

Johnson Roney II, Clearwater, Fla., and Industrial Sales & Engineering Company, Buffalo, N. Y., have been appointed field representatives of Mixing

Threaded Bar Stock
THERMOWELLS

Type T-100 Series TRINITY Threaded Bar Stock Thermowell

T-100 – 1" SPT – 3/8" bore for ⌀14 Gauge Thermocouples.
T-101 – 1" SPT – 13/64" bore for ⌀20 Gauge Thermocouples.
T-102 – 3/4" SPT – 3/8" bore for ⌀14 Gauge Thermocouples.
T-103 – 3/4" SPT – 13/64" bore for ⌀20 Gauge Thermocouples.

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The REFINER in making this announcement in the June issue inadvertently transposed Roney's names.

Davison's Baltimore Office Moves to New Quarters

The Davison Chemical Corporation, Baltimore, has opened new offices and headquarters, in its home city, occupying six floors in the newly renovated and air-conditioned Davison Chemical Building, Charles and Fayette Streets.

The building, purchased by Davison over three years ago for a permanent home was erected in 1898. It is a 12-story structure located in the heart of Baltimore's business district with a total floor area of 50,000 square feet, of which Davison will occupy 25,000.

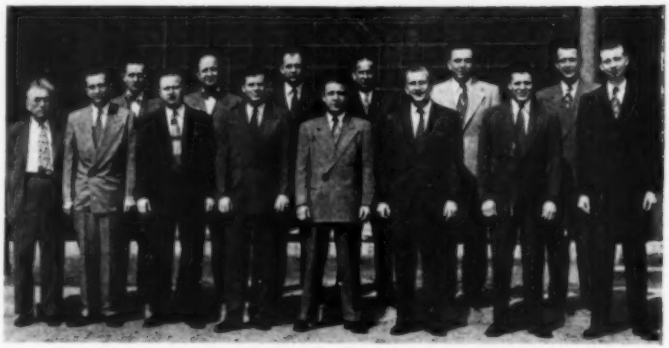
The manufacturing and research activities at Baltimore's Curtis Bay plant will remain at that location.

Davison now operates ten plants in strategic locations throughout the nation.

Arcos Appoints C. T. Posey Midwest Field Engineer

C. T. Posey has been appointed field engineer in the midwestern area for Arcos Corporation with headquarters at 1324 Fulton Street, Chicago 7. Posey, who has been associated with Arcos Corporation since 1946 as field engineer, will assist the Arcos distributors in this area, Machinery and Welder Corporation and C. E. Phillips & Company, in their stainless steel electrode sales activities.

Sales Group Hear Factory Men



The sales force from the eight offices of Eggelhof Engineers recently held a three-day sales meeting at the Houston office. Chief engineers of Cuno Engineering Corporation, Meriden, Conn., C. H. Wheeler Manufacturing Company, Philadelphia, and Todd Combustion Equipment Division, New York, were present to review the technical details and application of their equipment. This sales meeting is a part of an educational program which includes besides semi-annual meetings in Houston an annual trip by four men to the factories to get better acquainted with the products, factory personnel and production facilities. In the picture, left to right, are: Front row—Henry Eggelhof, Jim Stafford and Jack Rush of the Dallas office; Bob Molnari, Leonard Meyer, Bob Behnken, Will Molnari and Frank Lenoir of the Houston office. Back row—James Powell, San Antonio, Garvice Hill, Lubbock, Gordon Catts, Corpus Christi, Henry Turner, New Orleans, Morley Hudson, Shreveport, and Hugh Brightwell, Tulsa.

Celanese Names Director

John W. Stevens has been named director of sales of the chemical division of Celanese Corporation of America. For the last two years Stevens was in charge of sales in the New England territory. He will now be responsible for the sales of organic chemicals produced at the Chemical plant, Bishop, Texas.

COMPLETE BULLETIN

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Stainless Steel Welding Fittings

1965 STOCK ITEMS to match pipe and tubing of various wall thicknesses in sizes from ¾" through 12", in three Stainless Types—304, 316, 347.

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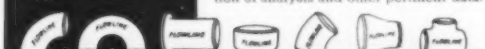
FLOWLINE stainless welding fittings are made of *forged* or *rolled* stock—no castings are used. The ends are accurately machine tool cut—fittings of wall thickness over .083" are beveled to 37½° with approximately 1/16" straight face; those with wall thickness of .083" or lighter are cut straight, not beveled. The fittings are annealed, cleaned, and passivated for maximum corrosion resistance. Each fitting is stamped for permanent identification of analysis and other pertinent data.



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Worthington Announces Sales Executive Appointment

Kehane

Summersby

John J. Summersby has been elected vice president in charge of sales by the board of directors of Worthington Pump and Machinery Corporation and Thomas J. Kehane was made assistant vice president and general sales manager.

Summersby joined the Cincinnati Works of Worthington Pump and Machinery Corporation in 1916 as a student engineer. In 1919 he was assigned to the St. Paul district office as a salesman and later was made district sales manager. He was manager of Holyoke works sales from 1929 to 1931; assistant general sales manager from 1931 to 1934; and since then has been assistant vice president and general sales manager. Summersby is a mechanical engineering graduate of Washington University, St. Louis.

Kehane studied engineering and architecture at Mechanics Institute and Pratt Institute, after joining Worthington in 1915 as a fourteen-year old office boy. Since then he has advanced through various positions in the sales department, and in 1944 was appointed commercial vice president, Pacific coast. For the past two years he has served as Pacific coast regional vice president of the Navy Industrial Association.

Graver and Phoenix Name Devendorf Export Manager

Engel E. Devendorf, former New York manager of Western International Corporation, has been appointed export manager for Graver Tank Manufacturing Company, Inc., East Chicago, Ind. and Phoenix Manufacturing Company, Joliet, Ill. Devendorf will handle the foreign phase of sales, advertising and promotion, and export for all divisions of the Graver and Phoenix companies.

Devendorf

A graduate chemical engineer of Stanford University, Devendorf has had 14 years' experience in the sales field and has recently returned from residence in South America.

Graver said it plans to revise and expand its foreign sales agencies and representatives in South America, the Far East, the Near East, and Africa with the appointment of Devendorf. Its export program has been enlarged to include newly designed water processing equipment, sugar refining, strip steel

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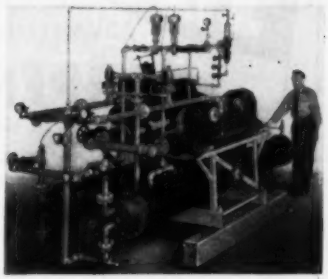

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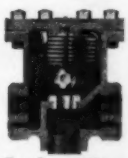
STOP BACK-UP of CONDENSATE



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Operate on Lowest Temperature Differential

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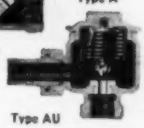
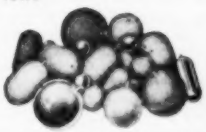


Type AU



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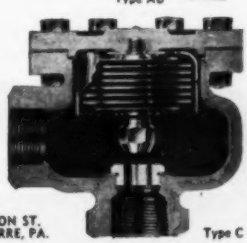

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Peerless Pump Announces Sales Department Changes

Hull

McCann

Peerless Pump Division of Food Machinery and Chemical Corporation, has announced two personnel changes in the sales department:

Frank W. McCann, previously head of centrifugal pump sales at the company's Indianapolis works, has been appointed manager of Peerless' Atlantic district sales with headquarters at 37 Wall Street, New York. Territory served by McCann includes all New England and middle Atlantic states.

Robert H. Hull replaces McCann at Indianapolis. Hull assumes new duties of sales manager of Peerless' engineered pump lines, including both vertical type pumps and horizontal centrifugal pumps. Hull previously was located at the Los Angeles works in charge of sectional sales of the vertical pump line.

Warren M. Pike Named Agent For Farrel-Birmingham In Boston

Farrel-Birmingham Company, Inc. has appointed Warren M. Pike New England representative, with offices at 274 Franklin street, Boston, to handle the sale of gears and gear units manufactured at the company's Buffalo, N. Y., plant.

Pike entered the sales engineering field in New England following his graduation from the University of New Hampshire in 1933 and was partner in the Arthur Pike Co. prior to joining the Army in 1940. During the war he was in the Pacific theatre for more than three years where he was colonel in the ordnance department, after which he returned to sales engineering in 1946.

Refinery Manufacturing Is Incorporated in Tulsa

Refinery Manufacturing Company of Tulsa has been incorporated to offer engineering, development and manufacturing facilities for scientific, laboratory and gas measurement equipment for the oil industry. Formerly, the R. S. Manufacturing Division of The Refinery Supply Company in Tulsa manufactured the RS and AC-ME specialty items exclusively for the company. The new company will provide a greatly improved and enlarged plant for the development and manufacture of scientific equipment. W. A. Schlueter, president, also heads The Refinery Supply Company which he organized in 1918.

Hooker Names Field Agent

Hooker Electrochemical Company has appointed Allen L. Spafford field salesman in the territory comprising upper New York state and western Pennsylvania with headquarters in the company's Niagara Fall's office. Spafford has been associated with Hooker for two years as a process study engineer. He is a graduate of Cornell University with bachelor of science and bachelor of chemical engineering degrees.

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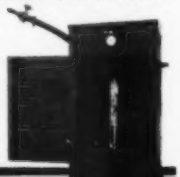

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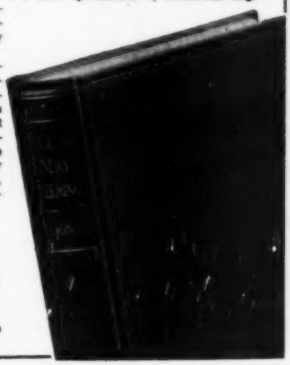
Illustrations or examples of almost all important calculations are included. The book builds up a few very important fundamentals and indicates how these may be used to work almost any type of plant problem, even those not directly associated with petroleum.



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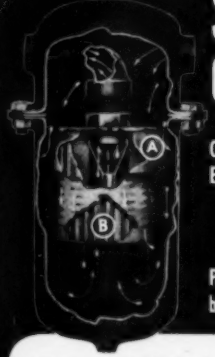

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By ORVILLE L. ADAMS

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The man who knows little, even the man who knows NOTHING of Diesel Engineering will find in these pages all that he needs to learn to qualify as a skilled Diesel man. Engineering standards, and the attitude of the Diesel industry are accurately presented. INSTRUCTORS in technical schools and colleges will find in this book an old friend—a text many of them found to be indispensable in their classes before the war, a book that stands on its own feet in a way many texts fail. The PROBLEMS, the QUESTIONS AND ANSWERS after each chapter are especially designed to help the class room teaching of this important field of engineering.

THE AUTHOR, Orville L. Adams, is widely-known in the publishing as well as the academic fields, and to an extent seldom found in one man, he combines practical experience with an intimate knowledge of the requirements of the school and college. ELEMENTS OF DIESEL ENGINEERING, as it appears in this new edition, could have been written only by an engineer, turned instructor, with sound experience in the preparation of books

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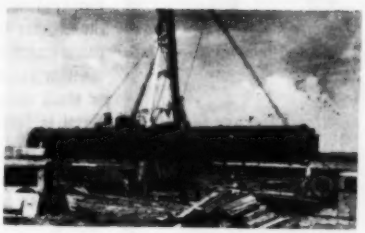

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Williams Named Edward Southwest Sales Engineer

Thomas J. Williams has been appointed sales engineer in the southwestern states by Edward Valves, Inc., East Chicago, Ind.

Williams

Williams received a degree in petroleum engineering from Louisiana State University. He was formerly employed by Pate Drilling Company in Texas and previous to that had been with the Texas Company. During the war he served in the Army Air Force. Recently he has been undergoing a training program at the Edward home office in East Chicago.

Williams will make his headquarters in Tulsa, with Rockwell Manufacturing Company.

Edward Valves Appoints Rowe as Sales Engineer

Herbert J. Rowe, St. Louis, has been named sales engineer for the Great Lakes region by Edward Valves, Inc., East Chicago, Ind.

A graduate of the University of Illinois, he also attended the University of Texas and studied engineering at Purdue University. For the past six months he has been training in the sales department of the home office in East Chicago, Ind. His headquarters will be at the home office in East Chicago, serving Edward Valve users in the Great Lakes region and working in cooperation with Edward representatives.

Babcock and Wilcox Tube Opens Boston Sales Office

An additional district sales office of The Babcock & Wilcox Tube Company has been opened at 250 Boylton Street, Boston, under the direct supervision of J. W. Bramley.

Bramley attended Ohio Wesleyan University, Delaware, Ohio and from 1937 to early 1949 he was with Lincoln Electric Company and J. E. Raney & Company, being associated the last nine years with their technical sales divisions in the New England district. He is a past director of the Worcester, Mass., section of the American Welding Society.

Metzger Named Sales Manager For the Midvale Company

Frank K. Metzger has been appointed general sales manager of The Midvale Company, Nicetown, Philadelphia 40.

Metzger has been manager of railroad sales since 1946 and prior to that held executive positions with The Baldwin Locomotive Works and its subsidiary, the Standard Steel Works.

Adds Tempil® Products to Line

Metal and Thermit Corporation of New York City has added Tempil® temperature-indicating products to its lines of welding accessories. Tempilstiks® and other Tempil® products are stocked by district offices and are available from their distributors.

Byron Jackson Pump Division Advertising Manager Is Named

T. R. (Bob) Colville, has been appointed advertising manager of the Pump division of Byron Jackson Company of Los Angeles.

Colville

After serving 3½ years in the service, Colville worked in the Advertising division of the Chemical department of the General Electric Company until last fall. Prior to the war, he was assistant program director for an eastern radio station. Colville was graduated from Syracuse University.

Lincoln Electric Revises Sales Engineering Staff

The Lincoln Electric Company has named E. E. Goehringer district manager in the Indianapolis area. Goehringer has been a district engineer for the company since 1935.

Omer Blodgett has been transferred to the Chicago office at 2450 South Prairie Street. Blodgett, with the company as an engineer in the Grand Rapids office since 1945, in addition to being sales engineer, has a special assignment in the Chicago area in engineering applications for redesigning to welded steel fabrication.

R. L. Hall and Robert Hirsch have been assigned as district engineers at Pittsburgh. Hall was graduated from the University of Michigan in electrical engineering, and Hirsch from Cornell University as a mechanical engineer.

Stephens Joins Quaker Oats

Norman C. Stephens, formerly with Union Oil Company of Oleum, Calif., has joined the chemicals department of The Quaker Oats Company, Chicago. He will handle technical sales of the furfural chemicals produced by Quaker Oats.

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CONDENSERS
and
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A major oil company has opening for Instrument Engineer with at least three years of chemical plant or refinery experience. Preference given to men with engineering background. Give qualifications, education, experience, age, and attach a small inexpensive passport photograph. Address: Box 155-R, c/o Petroleum Refiner, Houston, Texas.

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Ashland Oil & Refining Company, Inc.
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National Supply Co. Appoints Bremmer to Head Manufacturing

F. W. Bremmer, for 25 years with The National Supply Company, has been elected vice president in charge of manufacturing, a position vacant since the retirement of Charles R. Barton a year ago. Bremmer has been works manager of the Spang-Chalfant division's Ambridge plant since May, 1948.

Bremmer

Upon Bremmer's graduation from Carnegie Institute of Technology with a degree in metallurgical engineering in 1924, he was employed by Standard Seamless Tube Company of Ambridge, Penn. He rose from Hot Mill foreman to plant metallurgist, and in 1929, shortly after the company was acquired by Spang-Chalfant, he became assistant superintendent of the Hot Mills.

Spang-Chalfant was acquired by National Supply in 1930, and in 1940 Bremmer was appointed works manager of the division's Etna, Penn. plant.

Wing Company Appoints Canadian, U. S. Agents

L. J. Wing Manufacturing Company, manufacturers of heating, ventilating and combustion equipment, has appointed Albert D. Becker representative for the eastern section of New York state, Vermont and Berkshire county in Massachusetts; and Fred McMeans representative for the province of British Columbia, Canada. McMeans, who has had experience in both operation and design of heat and power equipment in marine and land installations, will maintain headquarters at Vancouver, B. C. Becker's headquarters will be in Albany, N. Y.

Weston Electrical Sets Up Offices in Washington, D. C.

Weston Electrical Instrument Corporation of Newark, and its subsidiary, C. J. Tagliabue Corporation (N. J.), have established a district sales office at 6230 Third Street, N. W., Washington, D. C. Lawrence F. Parachini is district manager of the office which will serve the District of Columbia and adjacent counties.

Parachini joined the Weston organization in 1928, working first on inspection and calibration of instruments, and later as a commercial design engineer. He then served as the company's educational division director and manager of educational and public utility sales, in which capacity he gained national distinction as a lecturer on instruments.

Worthington Names McArthur West Coast Sales Manager

Worthington Pump and Machinery Corporation has announced the appointment of John P. McArthur as manager of west coast sales, with headquarters in San Francisco. McArthur will supervise the activities of the Los Angeles, San Francisco, Seattle and Salt Lake City district offices.

A graduate of Penn State, McArthur was born in Altoona, Pa., in 1907. He joined Worthington in 1936 as an estimating engineer in the Philadelphia district office and became a sales engineer two years later. In 1945 he was made San Francisco district manager.

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Inside story of the

300 TANKS

made for rugged

ALASKAN SERVICE

They're fabricated from

REVERE HERCULOY

The silicon-bronze alloy of great strength and corrosion resistance

ALASKA is no place for sissies, whether they be men, metals or alloys. Rugged service calls for rugged materials. That's how Revere Herculoy came into this picture. The tanks illustrated, which had to be made to a combination standard of ASME and Army specifications, are of 1250 gal. cap. and made for a working pressure of 127½ lbs. Each tank receives a 300 lb. hydrostatic test before shipment.

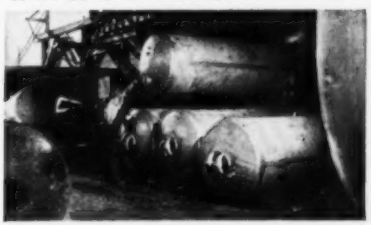
Herculoy was chosen for this job because of its unusual properties. This silicon-bronze alloy has the corrosion resistance of copper with the strength of medium carbon steel. It cold-works and hot-works readily and is easily welded by any of the commercial methods, its thermal conductivity being roughly only 10% of that of copper and comparable to that of mild steel, thus high thermal losses of conduction are not encountered. In the case of the tanks shown the welding method employed was the Heliarc process, using ¼" Herculoy rod. Tanks were welded both inside and outside.

Herculoy also has superior fatigue resistance, and is used in operations requiring resistance to alternating and cyclic stresses. It is but one of the many Revere Metals and Alloys and combinations of alloys being used more and more by more and more industries for the really tough jobs. For these industries have found there are many uses for copper and copper alloys of which they had never before dreamed . . . uses that have resulted in substantial savings, longer life, improved performance. They have also found that because of the many years of experience working with copper, Revere Technical Advisory Service can be of real help in solving many of their problems.

So, before placing your next order, why not call the Revere office nearest you?

ROLL OUT THE TANKS—Here you see a sheet of Revere Herculoy being rolled into cylindrical shape at the H. AMICK SHEET METAL WORKS, Seattle, Wash. Heads are then welded onto both ends of these cylindrical shells.

HOT SHOT FOR COLD TANKS—After welding is completed a removable heating element made of Revere Copper tube is placed into the tank. These elements range in sizes of from 3 sq. ft. of surface to 750 sq. ft.



HEADED FOR THE FROZEN NORTH—These completed tanks awaiting shipment are 48" x 168" and are the largest of the group of some 300 made of Revere Herculoy by H. AMICK SHEET METAL WORKS for use in Alaska.

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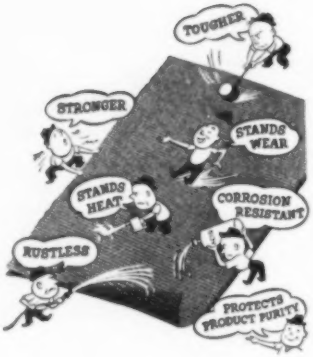

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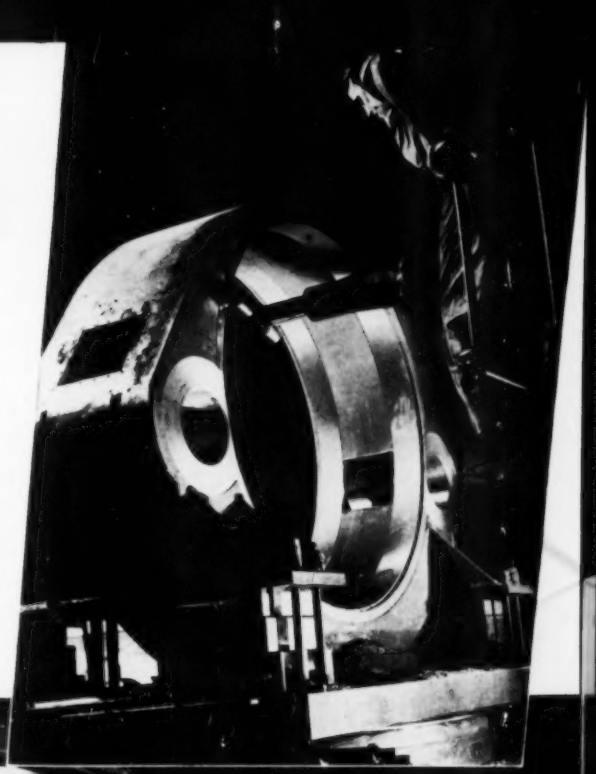

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